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ABSTRACT

This study evaluates the economic and financial aspects of the application of teleprocessing and telecommunications to the transfer of scientific and technological information, especially in the context of developing countries. It was intended to facilitate comparison of the relative value of a teleprocessing network with that of other modes of information distribution. The study was restricted to networks of bibliographic information services in three regions: (1) Arab Region with Cairo as regional center, (2) South East Asian Region with Kuala Lumpur as regional center, and (3) Andean Region with regional center to be selected. Technical issues addressed include specification of requirements, technology and costs, network design, regional networks, economic considerations and comparative evaluations, and some specific information network problems with suggested solutions. A series of annexes document current experiences of information retrieval operations, including the role of intermediaries, development issues concerning the interface between humans and computers, international leased circuits, and annual costing for regional centers. (JEG)

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INFORMATION NETWORKS FOR

ON-LINE BIBLIOGRAPHIC RETRIEVAL

Prepared for the Unesco UNISIST Programme
by Bo Karlander and Sverre Sem-Sandberg

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INTRODUCTION

For some time it has been apparent to those responsible for the development of the UNISIST [1] programme, sponsored by Unesco, that telecommunication technology would be a crucial element in the coming years in the development of modern information systems and networks. Subsequently enquiries were made in 1973-74 to IFIP [2] to explore ways in which its Technical Committee on Data Communication, TC-6, could be of aid in the planning and selection methods to support regional networks for the exchange and maintenance of on-line bibliographic information. In May 1974 a contract between UNESCO and IFIP was signed, calling for a study by IFIP TC-6 on the subject. The results of this study is presented in this report and associated annexes.

In the UNESCO-IFIP contract, the first article identifies the basic objective of the study to be:

"The purpose of this study is to evaluate the economic and financial aspects of the application of teleprocessing and telecommunications to the transfer of scientific and technological information, especially in the context of developing countries. Its results will further serve to make a comparison of the relative value of a teleprocessing network with that of other modes of information distribution, to make the results of the study of practical interest to developing countries. It will be restricted to networks of bibliographic information services."

In an attempt to further restrict the study to practical dimensions, the contract also requests that three particular regions should be considered.

1. Arab Region with Cairo as Regional Center
2. South East Asian Region with Kuala Lumpur as Regional Center
3. Andean Region with Regional Center to be selected.

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1) UNISIST is an acronym for the program of international cooperation in scientific and technical information whose aims are to coordinate existing trends towards cooperation and to act as a catalyst for the necessary developments in scientific and technical information. The ultimate goal of UNISIST is the establishment of a flexible and loosely connected network of information services based on voluntary cooperation.

2) International Federation for Information Processing

Several traffic models are indicated in the original UNESCO-IFIP contract. Network information of sufficient detail in all practical locations has not been available. It was therefore initially felt that a quantitative analysis could be made on network models only. Subsequent qualitative comparison between the models and larger regional networks would have permitted practical conclusions to be drawn.

In the final analysis it has been found, however, that for practical applications, the quantitative analysis of a small and a large network for each region would be of greater value to a potential user. The result of such analysis is therefore presented in this report. It should be understood that, based upon available information, this analysis represents, with its inherent flaws, as good a picture of the situation as can be accomplished without special studies of considerable penetration. Such studies are way beyond the scope of this report. The authors will, however, upon request advice on possible resources for such additional work.

It will be found that the economical and financial aspects of a study of this type is very much a function of other factors. In particular, the state of the art of present communication technology, development potential and direction of information systems in a pragmatic 10 year perspective, as well as specific regional problems, all add up to a complicated technical picture. It is not surprising therefore, that the major portion of this report adresses the various technical issues of information networks.

The economic and financial aspects are found in Chapter 6 and to some extent in Chapter 3. It will be noted that whereas equipment, lines and certain software may be assessed in monetary units, this is not the case with manpower. Development and implementation for an international project may be effected in different parts of the world. The cost of qualified manpower varies too much to permit the use of monetary units. For this reason certain development and implementation costs are given in terms of type and number of man-years.

The basic initial material for this report was assembled by members of the special working group created within IFIP TC-6 for the purposes of this report, W G 6.2, and subsequently discussed within this group. As it became evident that this was not a practical way to realize the final report, Mr. Keith W. Uncapher of ISI [3] and IFIP President Dr. R. I. Tanaka asked Mr. Sverre Sem-Sandberg [4] to assume responsibility for the editing, assembly and timely delivery of this report. The dominant portion of the report has been written by Mr. Bo Karlander of the same department and company. Acknowledgement and thanks are due the Management of Telefonaktiebolaget L M Ericsson for making this work possible.

In addition to the contributors that are identified as authors of individual annexes, numerous suggestions, practical calculations and some initial advice was received from Mr. Keith Uncapher and Dr. Vint Cerf [5]. Information on telecommunication tariffs in the South East Asian Region was collected by Hiroichi Teramura [6]. Valuable suggestions regarding international networks and their interconnection were received from Louis Pouzin [7] as well. The initial enthusiasm of Dr. Kjell Samuelson [8] in his capacity as Chairman of W G 6.2 and his contributions to the definition of the regional networks, to some parts of chapter 1 and 5 is hereby acknowledged.

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3) ISI is an acronym for Information Science Institute of University of Southern California (USC). Mr. K. Uncapher is Director of ISI and past Chairman of TC-6 after Mr. A. Curran, who resigned late 1974 due to other responsibilities within his company.

4) Mr. Sem-Sandberg is Head of Information Systems and Computer Technology within the Corporate Technical Staff of Telefonaktiebolaget L M Ericsson, Stockholm, Sweden.

5) Stanford University

6) Hiroichi Teramura is with Kokusai Denshin Denwa (KDD), Tokyo, Japan.

7) Louis Pouzin is present Chairman of TC-6 and associated with Réseau Cyclades.

8) Dr. Kjell Samuelson is employed at the Information Processing Department of Stockholm University and Royal Institute of Technology.

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1 GENERAL CONSIDERATIONS

1.1 STRUCTURING OF INFORMATION NETWORKS

The rapid progress of technology within the fields of computers and telecommunications has contributed to make the retrieval of scientific and technical information via international networks a practical reality in large areas of the world.

The TYMNET, the GE Mark III Network and the ARPANET are examples of US-based computer networks with international extensions (mainly to Europe) providing access to a large number of data bases. The European Space Agency - Space Documentation Service (ESA/SDS) operates a network with access points in most countries of Western Europe. It can also be accessed over a connection from TYMNET. Apart from the experimental European Informatics Network (EIN), at least two international networks aimed at the distribution of information from data bases are planned to become operational in Europe in the near future. These are SCANNET, which is a network for the Nordic countries, and EURONET, which is a project initiated by the European Community (PAGE 75, PAND 75, NILS 76).

The ESA/SDS network serves to distribute information from one central location (Frascati in Italy) to a widespread population of users and it is thus an example of a network of centralized type. Newer networks, like SCANNET and EURONET, will be organized in a decentralized or distributed form, i.e. they will allow service resources to be connected to any node in the network and by this be made available to all users with network access. These networks can thus be said to constitute a general infrastructure for information exchange within their regions.

Distributed networks have obvious advantages in international applications, as they enable each nation's specific information resources to be "marketed" to a wider population of users on an equal basis. A distributed network is also less vulnerable than a centralized one, because there is no total dependency on the functioning of any single center.

These considerations have lead us to the conclusion that the structure and technology to be applied to the regional networks in this study should be tailored to a distributed mode of operation. It may very well for practical reasons be so that the initial services are concentrated to one center in each region as is visualized in the traffic models defined in the contract for the study. However, in order to allow easy connection of distributed services and flexible expansion of network coverage, as will certainly be required if the networks prove successful, it is necessary that the networks already from the beginning are designed to allow distributed operation.

1.2 INFORMATION RETRIEVAL

1.2.1 State of the Art

Information Retrieval (IR) has little or nothing in common with library automation alone, although occasionally this misconception is found in review articles. Today's IR practices mainly consist of computer processing of information references originally recorded on magnetic tapes and then unloaded onto disc storage. The references mainly represent Scientific, Technological, Industrial and Business-related information from the world literature and patents in these fields.

It is worth mentioning that while during the 1960's the information mainly did come from Science and Technology, now during the 1970's there exists an obvious trend to gradually include more material from the Social Sciences of importance for economic development. Without intent of being exhaustive, the list in Table 1.1 of 49 commonly available data bases gives some indication of the state-of-the-art and possibilities for multi-disciplinary information retrieval. A majority of the listed data packages are available on a contract basis, while a few of them are only offered as a service from specific time-share operations. The total accessible volume of different reference items in the data bases well exceeds 12 million already today. It is obvious that distributed and decentralized utilization of the data bases is the most suitable solution internationally. The per annum growth rates span from the order of 10 000

TABLE 1.1 COMMONLY AVAILABLE DATA BASES

COMPUTER-READABLE DATA-BASE	SUBJECT FIELD
Science, Engineering and Technology	
AIP-Abstracts	Petroleum
AIP-Patents	"
Bulletin Signalétique CNRS	Science
CA-Condensator	Chemistry
CICP	Engineering Conferences
COMPENDEX	Engineering
CPI	Engineering Patents
ELDOK	Electro Technology
GEO-REF	Geosciences
GRA	US Governemental Reports
HRIS	Road Reasearch
IAA	Aerospace and Technology
INIS	Nuclear Science
INSPEC	Science Engineering and Technology
IRRD	Road Research
ISMEL	Mechanical Engineering
MECH EN	"
METADEX	Metals
NSA	Nuclear Science
PANDEX	Science and Technology
POST	Chemistry Polymer Patents
SCI	Science and Technology
SPIN	Physics
STAR	Aerospace and Technology
TITUS	Textile
WOOD	Paper, Pulp and Forestry

COMPUTER-READABLE DATA-BASE	SUBJECT FIELD
Social Sciences and Medicine	
CIJE	Education
DRUGDOC	Medicine
ERIC	Education
Exerpta Medica	Medicine
INDEX Veterinarus	Veterinary
IPA	Pharmacy
MEDLARS	Medicine
RINGDOC	Pharmacy
SSCI	Social Sciences
TCD	Toxicology
VETDOC	Veterinary
Other	
ABI-Inform	Business
Air Pollution Abstracts	Environment
AGRIS	Agricultural
BA-Previews	Biology
CAIN	Agricultural
CMA	Chemical Market
EMA	Electrical Market
FRUITS	Food
FSTA	Food
F&S	Business and Economics
INTREDIS	Forestry
New York Times	News and "Olds"
PIP	Environment

to approximately 400 000 references. The doubling period varies between 4-7 years at present.

Distributed operations also contribute to increased overall reliability, particularly since some information content overlap is unavoidable in real practice. The distributive mode of retrieval operation directly justifies that it be combined with teleprocessing networks.

1.2.2 Input Networks

The majority of computer-readable tapes listed are usually compiled and produced by some single body, publisher or organization. Yet, there are a few examples of input being undertaken in decentralized mode, e.g. INIS, AGRIS and ERIC. Likewise, LIBRIS in Sweden is intended to serve the purpose of remote decentralized card cataloging. Similar arrangements are operational at OCLC in the USA.

The body of knowledge synthesized and collected grows in the different corners of the world. It then becomes inevitable to share the work load of input. This has hitherto been done off-line and the input networks have been of a logical rather than physical nature. It is foreseeable that several decentralized input nets will come into existence that actually have remote input through teleprocessing.

UNISIST is partly sponsoring several projects for national contributions to Universal Bibliographic Control based on the ISSN and ISBN (International Standard Serial and Book Numbers, respectively). Once the regional teleprocessing networks have been established, it will be possible to use them for direct input, text editing and transfer to storage of such information items. This is one of the most direct ways in which the information systems and centers linked to the networks can contribute to building up local files of regional material in the original natural languages.

1.2.3 Current IR Developments

Information Retrieval is not an end in itself. It is mainly the first and most important step in a series of communication processes. Thus, computerized IR can be regarded as a multi-dimensional, cross-disciplinary table look-up in the "World's Best" and largest directory.

Neither are the reports and documents that are stored and later retrieved an ultimate solution. They may rather be regarded as uni-directional messages which are symptoms of a non-perfect communication. Once the relevant reference bits have been retrieved, the problem of locating the holdings of full information or answering the questions exists: Who has got, How Much of What information, Where, When, for Whom, at Which Cost? In other words, the logistics and inventory problem is linked to the IR situation. Looking at all the functions and steps connected to interactive IR, we may identify the following:

1. Awareness and promotion of IR facilities
2. Tutorial and instruction to use IR
3. Profile negotiation
4. Search results
5. Locator of hits against holdings files
6. Delivery of facsimile, hard copy or pictographics
7. Teleconferencing and follow-up actions.

When reviewing these stages, it becomes obvious what benefits really appear in combining IR with computer communication networks. Since it is actually a matter of multiple dialogs that could all be carried out over the same teleprocessing network, the cost-effectiveness will increase with every additional step implemented.

In order to achieve the economy of scale for message traffic, there should be an increased number of ports, terminals and access points as well as additional features like facsimile, teleconferencing and pictographic transmission. This, in turn, has implications for the choice of network technology.

2 SPECIFICATION OF REQUIREMENTS AND BASIC ASSUMPTIONS

2.1 GEOGRAPHICAL EXTENSION OF REGIONAL NETWORKS

The contract specification for the three regions suggest the following rough characteristics for each region:

(1) 3-5 national centers (NC) linked to the regional center (RC).
The distance from national to regional center is 1500-2000 km.

(2) 3-5 terminals linked to each national center (at a distance of 500-1000 km).

We believe that the potential demand for IR services in the future might justify the provision of access from a considerably higher number of terminals within each region. In order to clarify the consequences of network growth we have chosen to extend the study in this direction. In addition to an initial network size of 1 RC and 5 NC:s, we have also treated extended networks with up to about 20 centers.

2.2 TRAFFIC CHARACTERISTICS

2.2.1 Traffic Models

The contract specifies three traffic models to be assessed in the study. Models I and II assume that the regional center possesses a computer with capability for search of data bases, while Model III assumes that the regional center depends on satellite links to information centers in the developed countries to respond to user requests.

In all three models the traffic is assumed to consist of the following main components:

a) Traffic exchanged between users and IR systems during the interactive phase of searches.

b) Batch response, such as printout of a final list of references, to requests given during interactive search.

c) Output of reference lists in connection with SDI (Selective Dissemination of Information) services.

The traffic patterns of models I-III are of a centralized nature due to the fact that all regional data bases are assumed to be located at the regional center. Access to information centers outside the region is also assumed to be routed via the regional center.

An evolution towards a more distributed traffic pattern is foreseen based on the considerations of Chapter 1.

Relevant quantitative information on alternative traffic patterns is not available and is not considered necessary for the purpose of this study. In general the consequence of more distributed traffic patterns can be expected to be a more evenly distributed load on the links and modes in the network. However, it may also result in a need for additional crossconnecting links in order to reduce the number of links that have to be traversed between a user and the serving host computer. (The number of links traversed affects the response time as is further discussed in Chapter 2.3.)

2.2.2 Bandwidth for Interactive Traffic

The contract offers some estimates of the length of bibliographic citations which might be retrieved from the bands of systems which could make up UNISIST. We have collected material from other sources describing measured activity in the SDC and the ESA/RECON bibliographic retrieval systems (see Annex I). We will present here an estimate of average and peak bandwidths required by typical users of bibliographic information retrival systems. These can be used in conjunction with the topologies for each model to estimate the required minimum line capacities needed to support users. For example, Table 2.1 below illustrates single user averages for SDC and ESA/RECON. The table is copied from Annex I.

Table 2.1

EXPERIENCE WITH COMMUNICATION REQUIREMENTS OF SOME ON-LINE BIBLIOGRAPHIC INFORMATION RETRIEVAL SYSTEMS

	Average connect time	Average bandwidth	Peak bandwidth	Average total characters
SDC	30 min	7,2 cps	30 cps(1)	13,000
ESA/RECON	37 min	55 cps(2)	500 cps(3)	120,000 (4)

(1) Determined by terminal speed

(2) Derived from estimated 120,000 characters over 37 minutes (see (4)).

(3) Some user terminals include 300 lpm printers.

(4) Measured 116 items retrieved. If these were all printed and each item was 1,000 characters, result would be as shown.

As can be seen from Table 2.1, the peak-to-average ratio ranges from about 4 for SDC to 9 for ESA/RECON . In addition, the ESA/RECON system has a peak rate of 500 characters/s which, in asynchronous mode requires circuits capable of handling 4800 bits/s. Restrictions to lower capacity circuits limits the maximum transfer rate that any particular user can acheive.

We will in the following consider the quoted traffic volumes of 13 000 and 120 000 characters per search as low and high estimates of the average number of characters per search.

In order to estimate the aggregate bandwith requirement from all terminals during the peak traffic hour of the day, we make the following additional assumptions:

- 1.25% of the monthly traffic volume is carried curing the peak hour. (This corresponds e.g. to 20 workdays per month and 25% of the daily traffic carried during the peak traffic hour.)

- The total number of searches per month is (as stated in the contract) 300 (500) for Model I and 1 000 (1 500) for models II and III. This refers to a network with one regional and 3 (5) national centers, where each center provides access for 3 (5) terminals.

With these assumptions the total interactive traffic volume during the peak hour corresponds to 0.21 (0.31) (Model I) or 1.04 (0.63) (models II and III) searches per terminal in the network. With the number of characters per search ranging from 13 000 to 120 000 the aggregate bandwith requirement for interactive traffic will vary between 8 bits/s and 103 bits/s per terminal in Model I and between 23 bits/s to 347 bits/s per terminal in models II and III.

These values represent a very wide range, The highest values correspond to an intensive utilization of high speed terminals. We think this is an unrealistic requirement. It should be acceptable, at least initially to limit the bandwidth to an average of 100 bits/s for each terminal in the network. It will of course still be possible to run some of the terminals at faster speed if there are other terminals which for the moment are not active or are working at an average speed lower than 100 bits/s.

2.2.3 Bandwidth for Batch Output

In addition to interactive traffic the network will carry batch output traffic in form of output of final reference lists resulting from interactive searches, and output of reference lists in connection with SDI services.

The monthly traffic volume resulting from this can be calculated from the following estimates given in the contract.

Final reference lists

The figures refer to a network of one regional and 3 (5) national centers, with 3 (5) terminals per center.

Model I

300 (500) requests/month
50 references/request
1000 characters/reference

This corresponds to $1.25 \cdot 10^6$ ($0.83 \cdot 10^6$) characters/month/terminal.

Models II and III

1000 (1500) requests/month
50 references/request
1000 characters/reference

This corresponds to $4.17 \cdot 10^6$ ($2.5 \cdot 10^6$) characters/month/terminal.

SDI lists

Model I

15 profiles/terminal
100 references/profile/month
1000 characters/reference

This corresponds to $1.5 \cdot 10^6$ characters/terminal/month.

Models II and III

50 profiles/terminal
100 references/profile/month
1000 characters/reference

This corresponds to $5 \cdot 10^6$ characters/terminal/month.

The bandwidth requirement for batch output is based on a maximum printing time of 320 hours/month (16 hours/day, 20 days/month). This criterion is derived from the assumption that batch output traffic can be avoided during the peak hours for interactive traffic, and that some of it can be carried during night-time.

With 10 bits/character we arrive at the following bandwidth requirement for batch output.

Model I	20 to 24 bits/s/terminal
Models II, III	65 to 80 bits/s/terminal

2.2.4 Traffic to Information Centers Outside the Region

In the case of Traffic Model III there is assumed to be no information centers within the regions. Instead all requests are relayed to information centers in countries outside the regions. The link or links that in this case connect each region with the information centers need to have a total capacity at least equal to the aggregate bandwidth requirement for the region. This can be calculated based on the specifications of sections 2.2.2 and 2.2.3.

2.3 RESPONSE TIMES

A fundamental requirement is that the information network shall allow users to search data bases in an interactive mode. A consequence of this is that the network must be able to carry conversational traffic without introducing unacceptable delays.

It has been shown (MILL 68) that in order to maintain the continuity of a human thought process in a conversational situation response times should not exceed two to four seconds. The acceptable delays are longer after the completion of a "closed" task than during the interactions included in the task.
If the user recognizes that a large amount of processing is required in order to generate the response, he may tolerate response times in the order of 10 seconds. If waiting times above 15 seconds occur the sense of conversational interaction disappears and the user's attention will be diverted.

The contract for this study specifies that the response time should be no more than 10-15 seconds during the dialog phase. According to the reasoning above, this approaches the upper limit of what may be acceptable in interactive work. The response time should preferably

be much shorter for simple functions e.g. during entering user identification or during browsing through a list of references.

The response time consists of a host computer part (waiting and processing time in the host) and a network part (waiting, transmission and propagation time in the network).

The design objective should be to keep the network part of the response time below 2-3 seconds (average value for the least favoured center during normal conditions). The value may be higher during link or node failures. This may require careful engineering of the network in regions where transmission rates are limited to 2400 bits/s or where many of the intraregional links utilize satellite routes. It may be difficult to meet this objective in the case when search requests are routed to data bases at information centers outside the region as in traffic model III. Sometimes longer response times may have to be accepted in exchange for economic access to large data bases.

2.4 RELIABILITY

In order to promote a widespread acceptance of the information retrieval services it is essential that they can be provided with a satisfactory reliability.

It can be expected that different users have different views of what constitutes a satisfactory reliability level. An availability of 99% will probably be deemed sufficient even by critical users whereas an availability below 90% is likely to be considered unsatisfactory by most users.

When designing a practical network one is often forced to seek a compromise between desired reliability and network cost. It is therefore advantageous if the basic network design provides for a gradual increase of reliability so that the network easily can be adapted to growing requirements.

In a network where all services are provided by one single host computer, as is envisaged in traffic models I and II, the availability of this computer constitutes an upper limit of the availability of services at the user level.

It is likely that the users in this case will find the network reliability sufficient if it well exceeds the reliability of host computers.

Another concept closely related to the reliability is the vulnerability of the network. A network is vulnerable if the damage of one single node or link disrupts all or a large part of the services for all or a large part of the users, no matter how unlikely the damage is expected to be. The vulnerability can be decreased by the provision of alternate routes between users and service resources. How far one should go towards decreasing the vulnerability is of course a matter of judgement which needs some assessment of costs versus risks.

As an example, in the Andean region, most of the international telephone circuits use the same satellite. An international network in this region will for the functioning of many of its links depend on the satellite, and thus be very vulnerable with regard to satellite failures. As the cost of other alternatives probably is prohibitively high and the risk of total satellite outage is negligible (there is a reserve satellite), the vulnerability on this point may be accepted.

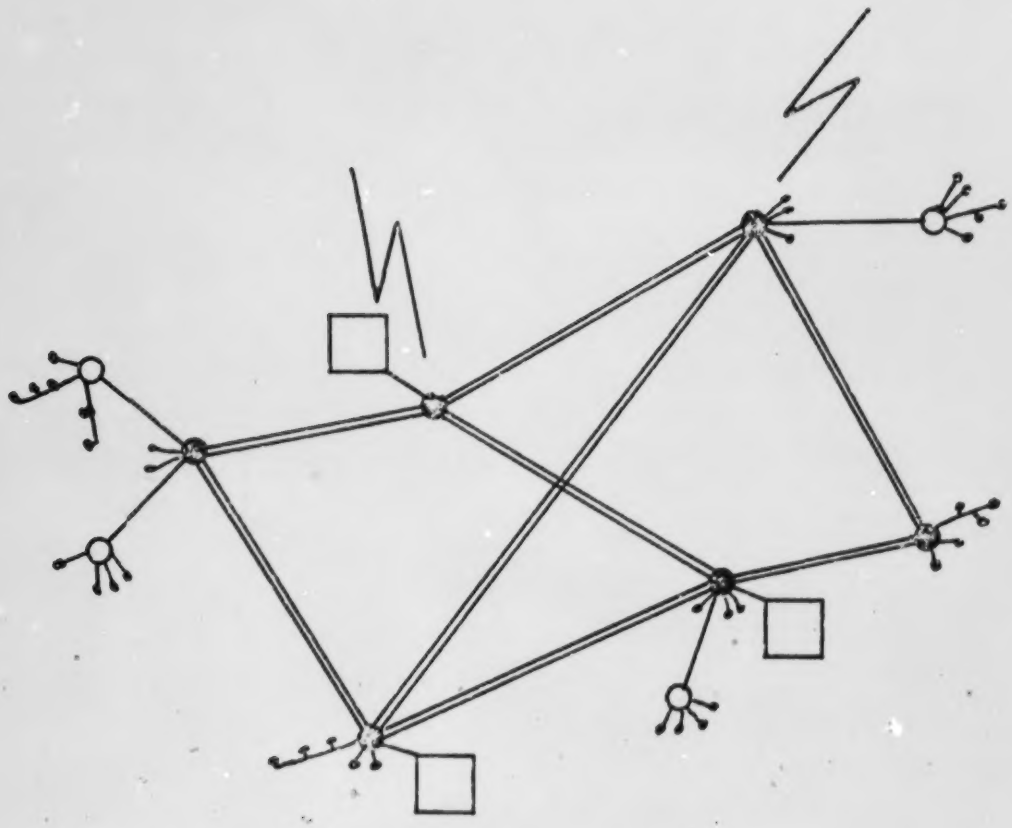
As a minimum requirement on the network, we propose that a user should not have to depend totally on the functioning of any other center than his own national center and the center providing the service he is using, Nor should a user have to depend totally on any single international line.

3 TECHNOLOGY AND COSTS

3.1 REGIONAL NETWORK

The regional center and each national center have to be interconnected in some way to form a regional network. Given the traffic characteristics, the traffic matrix, the response time and reliability requirements, the network design is a rather straightforward task from a technical point of view. This is especially so when the traffic pattern is as simple as assumed in the models I-III, where all traffic is directed to or from a central point, the regional center. In this case a simple star- or tree-shaped network would seem to be adequate, provided the reliability and non-vulnerability objectives could be met in this way.

We do however think that some other factors should be given thorough consideration already in the early design phase of an international information network of the studied kind. These factors are its ability to adapt to changes in the traffic pattern and its ability to grow in an evolutionary way. More specifically we recommend that the network topology and the communication procedures are designed according to the principles for distributed networks. By designing and connecting national centers as network nodes, it then becomes possible to connect additional host computers with local data bases to any of the national centers. It should be possible to make new resources available over the network in this way without changes in other nodes of the network. It should also be possible to expand the network by connecting a new center to any one of the existing network nodes according to capacity and reliability requirements. These considerations lead to the requirement to use a flexible communications procedure which is symmetrical in the sense that there is no difference from the procedural point of view between the different nodes of the network. This requirement can be met by a store-and-forward network using packet-switching technology. This solution will also make it possible to achieve desirable reliability and vulnerability properties by allowing a network topology with multiple routing possibilities between any two nodes. Figure 3.1 illustrates the envisaged network structure.



information center with data bases

network node (packet switch)

remote terminal concentrator

terminal

link to extra-regional information center

FIGURE 3.1

DISTRIBUTED INFORMATION NETWORK

Such national centers that have no transit function in the network and that will not provide network access to any local service resources may, at least initially, be adequately served by a remote terminal concentrator, whereas the regional center and those national centers with transit or service functions should be connected as nodes in the packet switched subnetwork.

For reliability and vulnerability reasons there should exist at least two separate routes between any pair of nodes. This requires each node to be connected to at least two other nodes. The nodes should be interconnected by leased telephone-type lines. Their data signalling rate should be determined according to traffical requirements. It should not be lower than 2400 bits/s and preferably be 9600 bits/s in order to achieve short response times.

National centers only having a remote terminal concentrator should have a leased line connection to one of the nodes for normal operation. As reserve mode it should be possible to use a dialled-up line which may operate with reduced speed. The normal data signalling rate may be between 1200 bits/s and 4800 bits/s mainly determined by the speed of its associated terminals.

3.2 NATIONAL NETWORK

The typical national network will contain 3-5 terminals linked to the national center. Depending on local conditions, such as terminal locations, availability and quality of leased and switched telephone lines, and level and structure of telecommunications tariffs, different solutions may be applied in different countries.

The structure of the national network will most probably be a simple star with permanent or dialled-up connections.

3.3 COMMUNICATION WITH INFORMATION CENTERS OUTSIDE THE REGIONS

As an alternative to establishing information centers with computers and data bases in each region, the regional networks may be used to provide access to existing information centers in the developed

countries. Several such information centers exist e.g. in USA and in Western Europe. Access to these could be arranged in alternative ways e.g. by:

a) Direct links from the regional networks to information centers.

b) Establishing connections between the regional networks and existing private international networks which already provide access to a large number of data bases.

c) Linking the regional networks to a small number of extra-regional nodes at selected locations in the developed countries. These nodes would be connected by direct links to information centers in their proximity and also interconnected in a global ring.

d) Incorporation major information centers, the regional, and possibly also some national centers, in a network based on packet broadcasting via satellites.

Solution a) may be the easiest to establish and administrate as long as each region requires access to only a few external information centers. Access to several more centers may however be desired in order to reach specific data bases, or for reliability and vulnerability reasons.

Solution b) has the advantage that it makes use of existing infrastructures. This should be an attractive solution, at least in the initial stage, as many large data bases could be made available without large new investments in lines and nodes. The interconnection of different private networks may pose some technical problems. Such interconnections have however been made for two-way traffic between ARPANET and TYMNET in USA and between CYCLADES in France and the NPL (National Physical Laboratory) network in U.K. Interconnections allowing one-way traffic from CYCLADES or TYMNET to ESA/SDS also exist.

Studies and experiments within this field are carried out by members of IFIP TC 6 (WG 6.1).

There seems to be a realistic possibility of a future American-European complex of interconnected networks giving access to practically all major scientific data bases. First, however, it has to be clarified to what extent such network interconnections conflict with existing regulations. The rights to provide public telecommunication services are normally reserved for national teleadministrations or specially recognized private operating agencies. The principles and practical methods of accounting and charging for services in interconnected networks will also need clarification. The legal and administrative obstacles may thus prove to be at least as difficult to overcome as the technical obstacles.

A solution of type c) involves building a new infrastructure with connections to major information centers around the world. Each region would be connected to this "high-level" network by two links for reliability reasons.

The high-level network would need to have at least three extra-regional nodes, located for example in North America, Europe and Australia. Each node would need direct links to several information centers. The investments and operational costs would be substantial. If such a network was established, there might however also be an interest from other countries outside the three studied regions to use it, which could contribute to its economy.

Solution d) is based on a rather new principle that has not yet been practised in large scale but seems to offer interesting advantages. Packet broadcasting means that all nodes share a common channel and transmit discrete packets of data on the same frequency. All nodes also receive on the same frequency and extract packets addressed to themselves while discarding other packets.

The transmission of packets can be completely uncoordinated between the nodes, as in the case in the ALOHA system (ABRA 70). This of course leads to frequent collisions and need for retransmissions of packets as the channel utilization increases. Other methods with differing degree of coordination have been proposed in order to increase the channel efficiency (ABRA 73, CROW 73, KLEI 73, ROBE 73).

The packet broadcasting via satellite is now under introduction in the ARPA network in USA, and will also be used in the new carrier network TELENET (TELE 74) in USA.

The interesting feature of packet broadcasting is that it permits several nodes to share a single channel, and thus achieve a statistical averaging of their total traffic, instead of having a fixed capacity reserved for each individual node-pair. The ground-stations can be made rather inexpensive if the gain of the satellite transponder is optimized for earth station antennas with a diameter of 3-5 meters. This can be done at negligible cost increase before the launching of a satellite. A thorough analysis of satellite packet switching economy and performance is reported in ERIC 75. The study, which was mainly directed to domestic networks in USA, indicated a total annual system cost per node in the order of $10 000 to $ 50 000. This includes the satellite cost, the earth station cost (one per node) and the node interface minicomputer.

The cost depends, among other things, on the required capacity of the satellite channel. The traffic volume specified for the regional networks will require only a fraction of the capacity of one satellite transponder. The annual lease of a transponder domestically in USA is reported to cost in the order of $ 1 000 000.

Reliable estimates of transmission costs in international networks of this kind are difficult to obtain, as the regulatory issues in connection with international interworking through a shared broadcast channel are not yet resolved. This may delay the introduction of this technology in international networks.

The technical and economic properties of packet broadcasting via satellite appear to make this principle otherwise well suited for the kind of information networks covered by this study.

The choice of a long-time solution for communication with information centers outside the regions obviously needs assessment of a number of factors other than technical, many of which clearly fall outside the scope of this study.

We have above discussed some of the possible solutions with an intent to stimulate further thought.

For the economic evaluation of the different traffic models covered by this study, we will concentrate on solution a) as we judge this case to be the most practical solution in the short term perspective.

3.4 LINES

3.4.1 National Lines

The terminals may be connected to the NC via switched or leased telephone-type circuits depending on traffic volume, tariffs and quality of the switched circuits.

In many countries the relation between tariffs for leased and switched circuits has a break-even point around three to four hours of circuit usage a day.

The quality of the national switched telephone networks may in some cases not allow data communications with desired bit rates.

These conditions vary significantly between different countries. A detailed analysis of suitable national network implementations and their associated costs requires complete knowledge of terminal locations and national tariff structures which is outside the scope of this study.

For the economic considerations we will roughly estimate the annual cost to $5 000 per line connecting a terminal to a concentrator or node, and $12 000 per national line between a concentrator and a node. These estimates include the modem cost.

3.4.2 International Lines

The type of circuit proposed for this connection is a leased telephone-type circuit.

The achievable transmission rate can be expected to vary between 1 200 and 9 600 bits/s. In many cases 9 600 bits/s may be possible on international circuits, but it may also happen that even 1 200 bits/s is difficult to use due to limitations of the national part of the circuit. For the further analysis it is assumed that 2 400 bits/s transmission facilities are generally available, and that 9 600 bits/s can be used on the major routes.

The international part of the circuit may in some cases include a satellite link.

Information on availability of and tariffs for international leased circuits is often difficult to obtain. The result of our efforts in this direction is reported in Annex III.

It can be seen that typical charges for international leased voice grade circuits are in the order of $10 000 to $20 000 per month. Between neighbouring countries the cost may be lower while intercontinental circuits cost in the range of $15 000 to $30 000 per month.

The application of packet broadcasting via satellite on the interregional level is discussed in section 3.3. This principle could be very well suited for intraregional traffic. There is however to date only limited practical experience and many regulatory issues will need to be resolved before it can be applied on an international level and it is very diffifult to estimate what the involved costs may be.

3.5 TERMINALS

The simplest user terminal can be a typewriter-terminal using asynchronous (start-stop) transmission at 10-30 characters/second.

The use of telex terminals is not recommended due to their limits in speed and character set.

Initially it may perhaps be acceptable to provide a 10 characters/s terminal, but due to the large amount of output during interactive search the users can be expected to very soon demand faster terminals.

A "Teletype KSR 33", 10 characters/s is priced at somewhat less than $1 000 while 30 characters/s terminals, such as "EXTEL/Transtel" or "GE/Terminet 30", presently are about twice as expensive.

A more expensive but also more efficient user terminal would be a VDU-terminal combined with a hardcopy-printer. As examples of such terminals the Teletype Model 40, or Hewlett Packard Model 2640 with printer Model 9866, can be mentioned. They have a maximum operating speed of 120 to 240 characters/s and are priced at about $6 000.

3.6 TERMINAL CONCENTRATORS

The minimum solution for a national center is the use of a terminal concentrator. This concentrates the traffic from a number of terminals into a single line connecting the national center to a node of the regional packet switching network. The concentrator should be of store-and-forward type. The preferred solution is to use a mini- or microcomputer performing packet assembly and disassembly in accordance with the protocols of the regional packet switched network.

The hardware cost for a concentrator of this type is estimated to $20 000.

The terminal concentrators may be equipped with dial-up facilities to provide a fall-back mode of operation (with reduced speed) in case of line or node failure.

3.7 NODE PROCESSORS

Each network node is assumed to function as a combination of packet switch and interface processor for local terminals and host computers.

It should be possible to connect host computers as well as remote terminal concentrators over leased lines, using dialled-up lines as reserves. For node-to-node lines only permanent connection is required.

The required throughput is at least initially rather low. A minicomputer in the low-price range with suitable interfaces will be able to meet the requirements.

The estimated hardware cost of the node equipment is $50 000.

3.8 SOFTWARE

Software development is expensive. Development of original software should therefore be avoided if possible.

The large number of packet switched networks developed or under development around the world, may open possibilities to buy suitable, proven software. Examples of networks with similar requirements are EURONET and SCANNET (see Chapter 1.1).

Minicomputer vendors are also beginning to supply network software, as exemplified by DECNET from Digital Equipment Corp, which could serve as a base for application oriented developments.

3.9 SUMMARY OF ANNUAL COST PER ITEM

The following estimates of annual costs are used as basis for the economic evaluation of different network models. As a general rule the annual total cost for equipment is calculated as 40% of the purchase price.

Equipment		Annual cost ($)
Terminals		
10 cps	(typewriter)	400
30 cps	(")	800
120-240 cps	(VDU + printer)	2 400
Terminal concentrator		8 000
Node processor		20 000
Lines		
National (incl modem),	terminal to conc.	5 000
" " ,	conc. to node	12 000
International		see Annex III
Modem	2 400 bits/s	600
	4 800 "	1 200
	9 600 "	2 400

4 NETWORK DESIGN

4.1 GENERAL

As can be seen from the general cost estimates in chapter 3, the network cost will be dominated by the cost of international lines. The estimated annual cost for a national center (4 terminals with national lines plus a concentrator or a node processor) ranges between $30 000 and $50 000, while the typical lease for an international line exceeds $100 000 annually.

A major requirement is thus to keep the number of lines in the network to a minimum. This unavoidably conflicts with the need to provide redundancy for reliability and vulnerability resons. Fewer lines may also result in longer response time due to that packets may have to travel a longer way between source and destination.

A more precise formulation of the design constraints, based on the requirement specification in Chapter 2, follows in the next section.

4.2 DESIGN CONSTRAINTS

4.2.1 Response time

In the requirement specification of Chapter 2 design objectives regarding response time and reliability have been formulated. In order to keep the response time within desired limits the number of links passed between the user's national center and the center to which the host computer is connected must not be too large. Based on an average packet length of 1 000 bits and an average link loading of approximately 50%, the permissible number of links has been estimated below for a maximum contribution of 2 seconds to the response time.

Transmission rate (bits/s)		Permissible number of links		
Satellite links	Terrestrial links	Satellite (S) only	Terrestrial (T) only	Combined S + T
9 600	9 600	2	7	2S+ T S+4T
9 600	4 800	2	3	S+2T
9 600	2 400	2	1	S+ T
4 800	9 600	1	7	S+3T
4 800	4 800	1	3	S+ T
4 800	2 400	1	1	-
2 400	9 600	1	7	S+T
2 400	4 800	1	3	-
2 400	2 400	1	1	-

These values can serve to give a general impression of the effect of the response time constraint.

It should be observed that the cost for upgrading the transmission rate from 2 400 bits/s to 9 600 bits/s on existing lines (where this is possible) is far less than the cost for addition of a new circuit. It is thus more favourable to reduce the response time by increasing the transfer rate on existing lines, than by decreasing the number of links in a connection by installing new lines.

Cases may be found where a rigorous adherence to the proposed response time constraints results in unacceptable costs and compromise solutions will be required.

4.2.2 Reliability

The requirements that a user should not have to depend totally on the functioning of any other center than his own and the one providing the service he is using, nor on any single international line, have direct implications on the network topology. It has lead to the formulation of the following principles:

1) Each host computer providing service to users at other centers of the network should either be connected to a network node via short direct lines or be able to establish connection over a dialled-up line in case of line failure.

2) Each network node should be connected by direct lines to at least two other nodes.

3) Remote terminal concentrators, which normally are connected to one node only, should be able to connect to some other node via dialled-up lines in case of node failure.

4.3 NETWORK TOPOLOGY

The number of lines required to connect n nodes is smallest (n-1) in a star- or tree-connected network. A ring-structure requires one more line but it provides decreased vulnerability against link or node damage. It also provides a good basis for gradual evolution of the network. A weakness of the simple ring-structure is however that the number of links to be traversed between source and destination becomes high if the ring is large. This might give intolerable response times if the used transmission rate is low, or if several satellite links are included.

As the ring grows cross-connections will have to be introduced for this reason. Cross-connections may also be required to increase capacity and reliability.

As a ring-structured network has one more link than a star-structured, one could expect the line cost to be higher in a ring-network. This is however not necessarily the case, as the average length per link may be lower in a ring-network.

The cost relation between these network types in a practical application will depend on the geographic location of the nodes and the tariff structure applied.

As the main purpose with this study is to explore only the order of costs involved in the regional information networks, we will not spend too much effort on seeking optimal topologies.

Referring to earlier discussed advantages of distributed networks we will concentrate the evaluation to ring- or mesh-structured networks.

The general problem of determination of links and capacities for a minimum cost topology has to be solved by heuristic methods, as no practical algorithmic solution exists. Heuristic approaches have been successfully applied to large and complicated networks.

The traffic estimates, on which the network dimensioning could be based, will however necessarily be very uncertain. Consequently, the dominant requirement on the initial network topology will be flexibility rather than capacity optimization.

5 REGIONAL NETWORKS

5.1 GENERAL

It is desirable to give this study a pragmatic orientation. Thus practical networks within the various regions will be identified.

This chapter will deal with these regional networks.

The practical networks studied in the chapter will be found to be considerably larger than the regional networks originally identified in the contract. The reasons for this are many, the major ones being:

1) The group of computer-, information- and communication specialists working on this study is not inclined to select 3-5 centers from a group as large as 20 or more within a region on the basis of available background information.

2) On the basis of UNESCO information on the location of major institutions, organizations and corporations assumed to be large scientific and technological information consumers, practical locations of centers and terminals for the respective regions have been worked out. The selected locations were found to be greater in number than originally anticipated.

3) It is felt that with the implementation of minimum information networks in the respective regions, there will be an almost immediate need to grow to the larger networks as indicated in this chapter. Thus, the analysis and subsequent specification of the requirements and implications of these larger networks should prove to be of considerable value in the immediate future.

In the analysis of the geographically bound networks, a number of factors escape appropriate assessment.

Complete information about national and international tariffs, quality of lines, bandwidth and type of switching employed is of considerable importance when designing networks. In spite of the energy and endeavour, as well as the number of sources consulted, complete information on all regions in all regards has been impossible to assemble. General characteristics of national or regional networks are known to sufficient depth, however. This enables a qualitative discussion of the individual regional network and its characteristics.

For each region alternative network topology maps have been drawn. They are the results of a rather sketchy application of the general design rules proposed in previous chapters and should only be considered as illustrative examples of possible solutions. The topology maps are used as basis for cost estimations, but it should be emphasized that they are not optimized.

It is recommended that a practical realisation of regional networks with large number of nodes are preceded by a more detailed analysis than possible within the scope of this study. As the typical link cost is in the order of $10 000 per link and month, it may be worthwhile to spend a substantial effort on finding better solutions.

5.2 REGIONAL CHARACTERISTICS

5.2.1 General Characteristics

Some general characteristics of importance for the information network implementation, which are in large common to all three regions, have been derived from various UNESCO studies.

There exist in the individual countries with a few exceptions:

- between 3 and 8 universities using and communicating Scientific & Technological Information (STI)

- between 6 and 12 Research & Development (R&D) institutions using STI

- more than 12 major corporations using STI and a variety of small-scale industries

- between 6 and 20 information centers, special libraries, productivity centers and research units using STI

- quite often bad conditions for local distribution of telephone traffic by the commercial carriers or national PTT authorities.

On the international level within each region it is generally true that:

- There are few direct telephone routes using cable or radio-relay technology.

- A few countries are still relying on radiotelephone circuits for large parts of their international telephone communications.

- An extensive use of satellite links has provided high quality international (and also national) telephone circuits to most countries and the remaining can be expected to follow within the near future.

5.2.2 User Communities

The regional communities of existing and potential users of information retrieval networks are foremost identical with those institutions and organizations which are engaged in research and development using scientific and technical information. In order to arrive at the magnitude of scale for terminals and local access points, a listing of such institutions and organizations within one of the regions (South East Asian) has been made. It is based on project reports from UNESCO and from the different countries in the region, and is presented here in random order. The listing is in no way exhaustive and many additional sites exist that may be characterized as potentional users.

South East Asian Region

Malaysia

NISIR, National Institute for Scientific and Industrial Research, Malaysia
Mara Institute of Technology, Malaysia
University of Malaysia, Kuala Lumpur
Rubber Research Institute
Malaya University
SEAMEO, Regional Centre for Education in Science and Mathematics, Penang
Malaysian Institute of Management
University Pulan Penang
University Kebangsaan Malaysia

Thailand

Chulalongkorn University, Bangkok
TNDC, Applied Scientific Research Corporation of Thailand
Chiang Mai University, Thailand
Thailand Management Development and Productivity Center
Ramkunihang University
National Institute of Development Administration, Bangkok
Association of Thai Industries
Mahidol University, Bangkok
Kasetsart University, Bangkok
Thammasat University, "

Singapore

Singapore Polytechnic
Singapore Institute of Management

Indonesia

University of Indonesia, Jakarta
LIPI, Indonesian Institute of Sciences
Institute for Management Education and Development, Jakarta
Biotrop, Bogor

Indonesia continued

Institute of Technology, Bandung
Cellulose Research Institute, Bandung
Institute for Textile Technology, Bandung
National Research Centre UPI, Bandung
University Airlangga, Surabaya
Institute for Technology, "
Gresik Cemen Library, Surabaya
Geological Survey of Indonesian Library
Materials Testing Institute, Bandung
Mining and Metallurgy Research Centre
Petroleum Institute, Jakarta
Power Research Institute, Jakarta
Industrial Research Institute, Jakarta

Burma

Rangoon University, Burma

Philippines

University of the Philippines, Manila
Asian Institute of Management
University of Philippines, Los Banos
National Science Development Board
Development Academy of the Philippines
University of Santo Tomas
Philcoman, Manila
University of Santo Tomas

Hong Kong

Hong Kong Polytechnic
Fisheries Research Station, Hong Kong
Commerce and Industry Department
Hong Kong Management Association
University of Hong Kong
Chinese University of Hong Kong
Hong Kong Productivity Center

Korea

KIST, Korean Institute of Science and Technology
KORSTIC, Korean Scientific Technological Information Center
Seoul National University
Korean University

Papua New Guinea

University of Papua New Guinea, Port Moresby
Papua New Guinea University of Technology, Lae

Fiji

University of South Pacific, Suva, Fiji

5.3 SOUTH EAST ASIAN REGION

5.3.1 Center Locations

A list of potential center locations is shown in Table 5.1. The regional center is placed in Kuala Lumpur.

5.3.2 Small Network

The following six centers are selected for the example of a small network.

MALAYSIA	Kuala Lumpur
THAILAND	Bangkok
HONG KONG	Hong Kong
PHILIPPINES	Manila
INDONESIA	Jakarta
SINGAPORE	Singapore

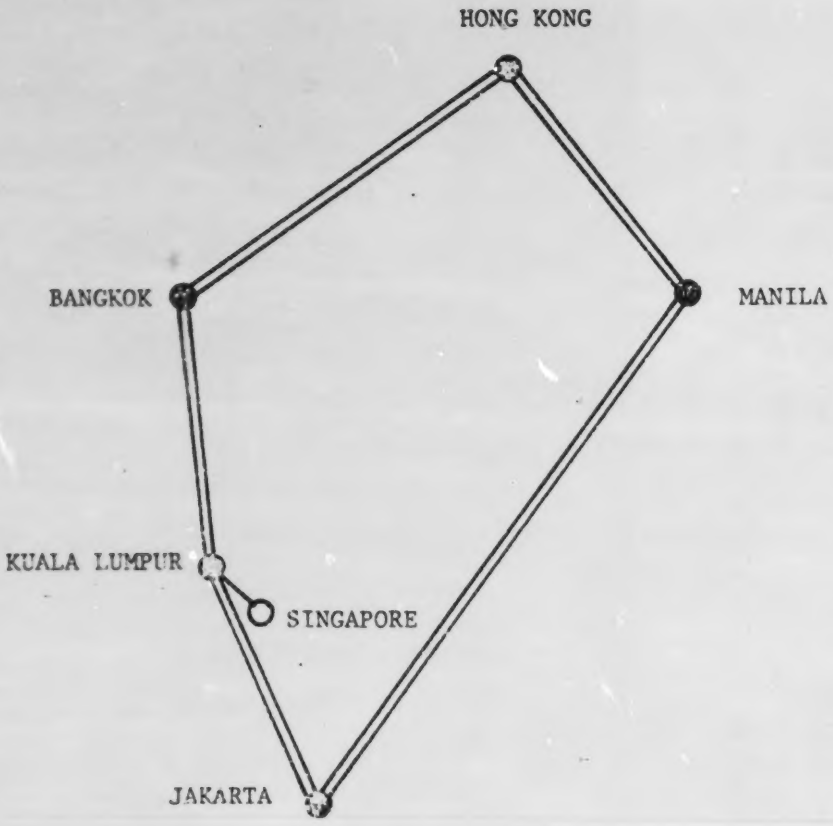
A possible topology map is shown in Figure 5.1

TABLE 5.1 South East Asian Region

Regional center

Malaysia: Kuala Lumpur

			Distance from regional center in km
National Centers			
1	Malaysia:	Penang	(300)
2	Thailand:	Bangkok	(1160)
		Chiang Mai	(1720)
3	Singapore:	Singapore	(305)
4	Indonesia:	Djakarta	(1160)
		Bandung	(1220)
		Bogor	(1200)
		Surabaya	(1680)
		Denpasar	(1980)
5	Burma:	Rangoon	(550)
6	Philippines:	Manila	(2130)
7	Hong Kong	Hong Kong	(1730)
8	Korea:	Seoul	(4775)
		Pusan	(4600)
9	Papua New Guinea:	Port Moresby	(4830)
		Lae	(4770)
10	Fiji:	Suva	(8100)



= NODE (PACKET SWITCH)

= TERMINAL CONCENTRATOR

FIGURE 5.1

South East Asian region - small network

With an average of 5 terminals per center the total bandwidth requirement is:

TRAFFIC MODEL	BANDWIDTH (bits/s) I	II, III
Interactive traffic		
- low/high estimate	270/3090	690/6246
- limit 100 bits/s/terminal	3000	3000
Batch traffic	600-720	1950-2400

Assuming separation in time between batch output and peak interactive traffic, and assuming limitation of average interactive bandwidth requirement to 100 bits/s/terminal, the total throughput requirement for the regional center is 3 000 bits/s in all traffic models. This could be handled by 2 400 bits/s lines in the network of Figure 5.1. In order to decrease response times, it is however proposed that 9 600 bits/s is used for all node-to-node connections if the circuit quality permits this. For lines connecting remote terminal concentrators to nodes, 2 400 bits/s is sufficient.

The traffic to be carried on extra-regional circuits in Traffic Model III amounts to 3 000 bits/s. With a utilization factor of at most 50%, a line capacity of at least 6 000 bits/s is required. For reliability at least two extra-regional lines should be used.

5.3.3 Large Network

Figure 5.2 shows a topology map for a network interconnecting all of the 18 center locations identified in Table 5.1.

The total bandwidth requirement for the network, assuming an average of 5 terminals per center, is:

TRAFFIC MODEL:	BANDWIDTH (bits/s) I	II, III
Interactive traffic		
- low/high estimate	810/9270	2070/31230
- limit 100 bits/s/terminal	9000	9000
Batch traffic	1800-2160	5850-7200

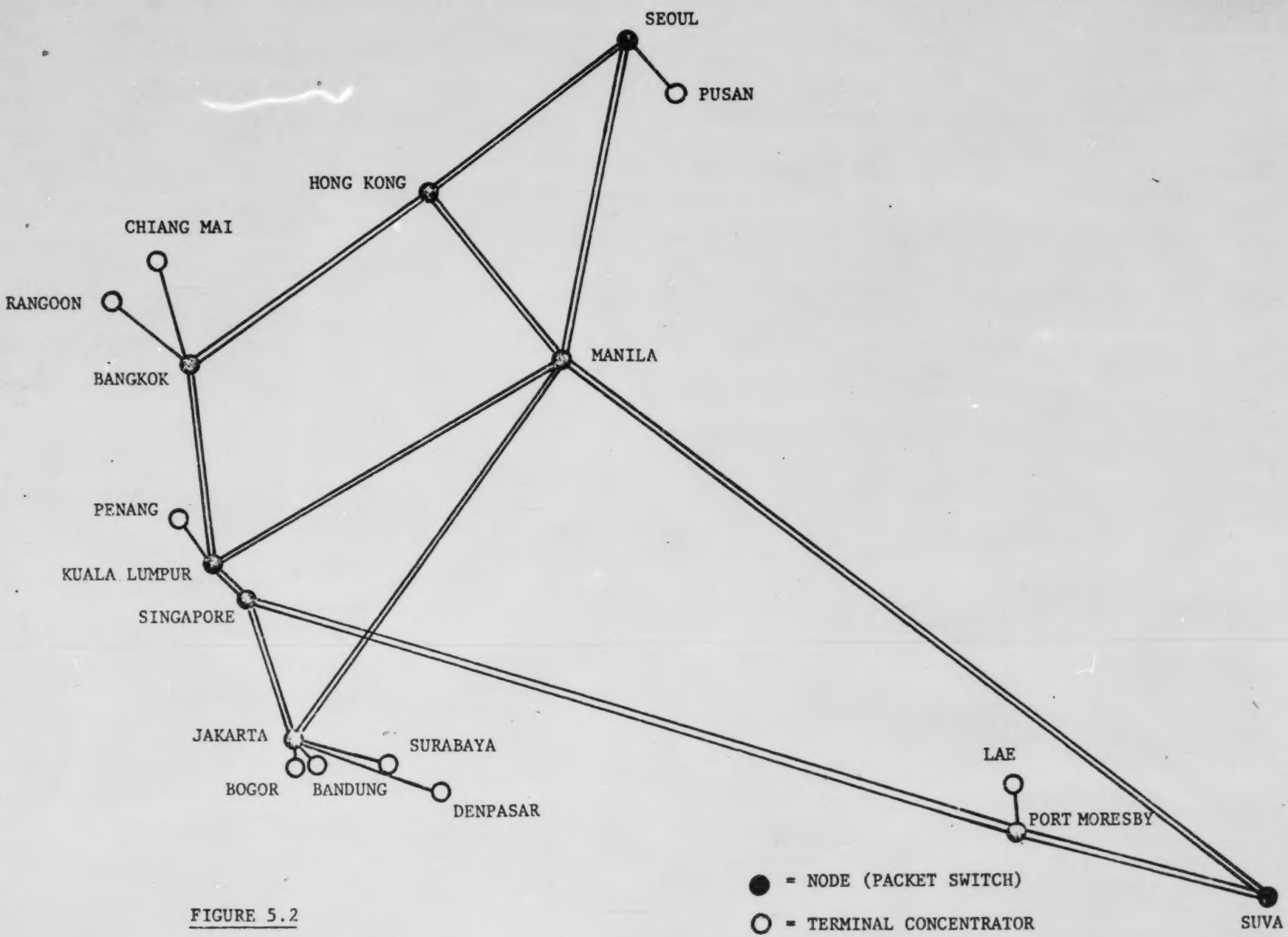


FIGURE 5.2

South East Asian region - large network

Assuming separation in time between batch and peak interactive traffic, and assuming limitation of interactive bandwidth to 100 bits/s/terminal, the total bandwidth requirement is 9 000 bits/s in all traffic models.

In order to handle this traffic when all services are concentrated to the regional center in the network of Figure 5.2, at least some circuits need 9 600 bits/s capacity. With a more distributed traffic pattern lower line capacities would be sufficient. A general use of 9 600 bits/s where possible on node-to-node connections is however proposed for reduction of response time.

If all services are to be provided by extra-regional information centers, at least two extra-regional circuits with capacity 9 600 bits/s will be required in order to carry the traffic. As there may be a need for connections to several different extra-regional information centers, we assume a total of four extra-regional circuits in this case (to Australia, Japan, USA and Europe).

5.4 ANDEAN REGION

5.4.1 Center Locations

Potential center locations are indicated in Table 5.2.

Lima has been selected as the location of the regional center. An alternative location could be Caracas for telecommunication convenience.

5.4.2 Small Network

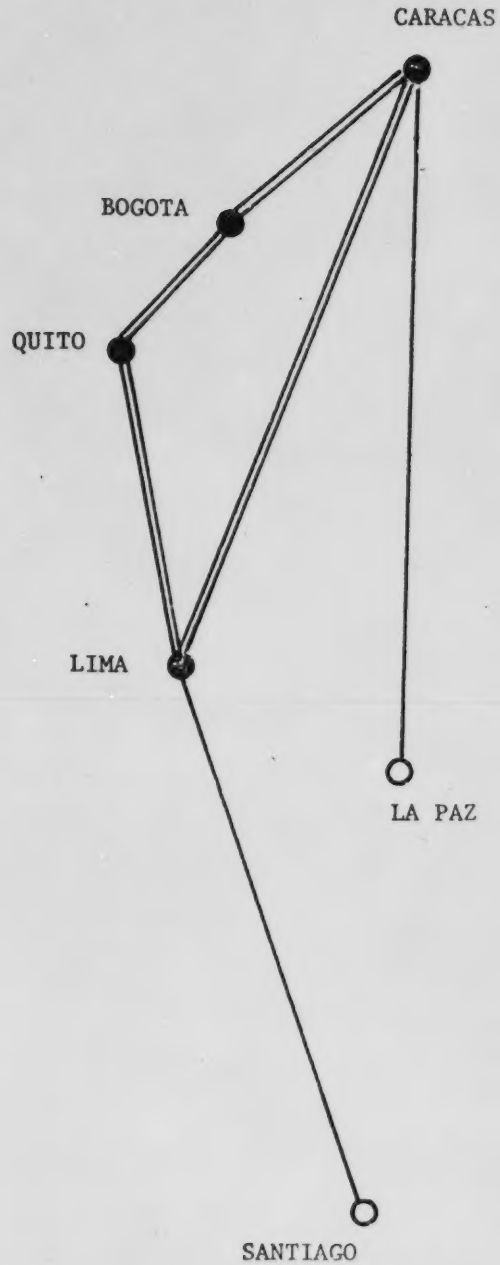
The following six centers are selected to illustrate a small network.

PERU	Lima
ECUADOR	Quito
COLOMBIA	Bogota
BOLIVIA	La Paz
VENEZUELA	Caracas
CHILE	Santiago

A possible topology map is shown in Figure 5.3.

TABLE 5.2 Andean Region

Regional center			
Peru: Lima			Distance from regional center in km
National centers			
1	Ecuador:	Quito	(1330)
		Guayaquil	(1140)
2	Colombia:	Bogota	(1140)
		Cali	(1720)
		Barranquilla	(2550)
3	Bolivia:	La Paz	(1070)
4	Venezuela:	Caracas	(2710)
		Maracaibo	(2550)
5	Paraguay:	Asuncion	(2610)
6	Chile:	Santiago	(2530)
7	Argentina:	Buenos Aires	(3250)
8	Uruguay:	Montevideo	(3430)
9	Brazil:	Brasilia	(3100)
		Rio de Janeiro	(3800)
		Sao Paulo	(3520)



= NODE (PACKET SWITCH)

= TERMINAL CONCENTRATOR

FIGURE 5.3

Andean region - small network

The required bandwidth is the same as for the network described in Section 5.3.2. Also the other considerations of that section apply equally well here.

5.4.3 Large Network

Figure 5.4 shows a topology map for a network interconnecting all of the 16 center locations identified in Table 5.2.

With an average of 5 terminals per center the total bandwidth requirement is:

	BANDWIDTH (bits/s)	
TRAFFIC MODEL	I	II, III
Interactive traffic		
- low/high estimate	720/8240	1840/27760
- limit 100 bits/s/terminal	8000	8000
Batch traffic	1600-1920	5200-6400

In analogy with Section 5.3.3 the total bandwidth requirement is considered to be 8 000 bits/s. Most of the node-to-node connections in this network will use satellite circuits. As a consequence there is an obvious risk of long response times. With the topology in Figure 5.4, some centers may have to use two satellite links, in addition to one or two terrestrial links, in order to reach some services. It is therefore proposed that, wherever circuit quality permits, 9 600 bits/s is used on node-to-node connections. We have assumed 2 400 bits/s to be used on concentrator-to-node connections, although this may not always be in line with the response time constraints identified in chapter 4. The bandwidth of the network will be more than adequate for the traffic requirements if these transmission rates are used.

Three extra-regional circuits are assumed for traffic model III (to USA, Mexico and Europe).

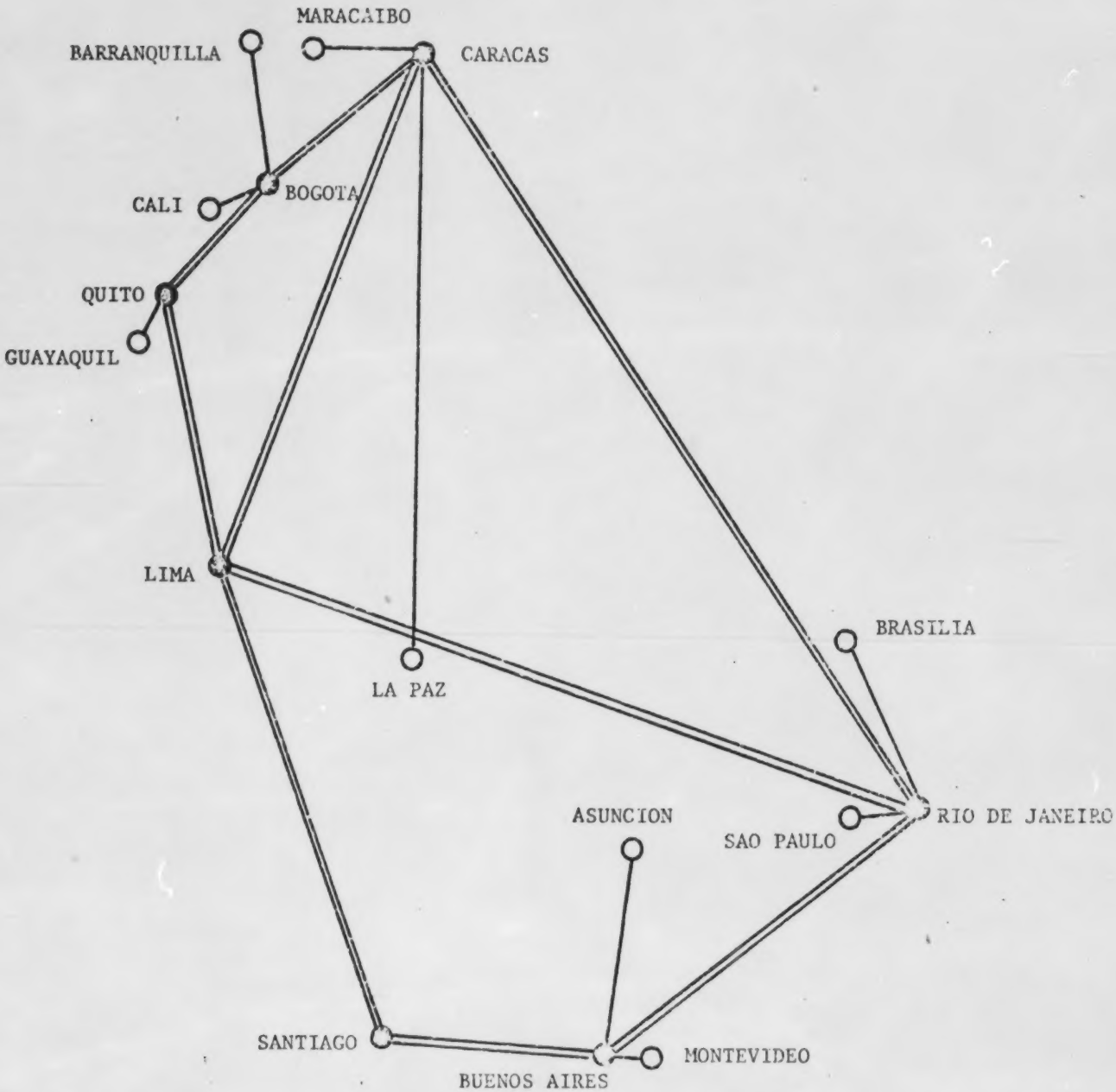


FIGURE 5.4

Andean region - large network

5.5 ARAB REGION

5.5.1 Center Locations

Potential center locations are indicated in Table 5.3.

The regional center is located in Cairo.

5.5.2 Small Network

As an example of a small network the following six centers are randomly chosen:

EGYPT	Cairo
SYRIA	Damascus
IRAQ	Baghdad
KUWAIT	Kuwait
SAUDI ARABIA	Riyadh
LIBYA	Tripoli

A possible topology is outlined in Figure 5.5.

The required bandwidth is the same as for the network described in Section 5.3.2. Also the other considerations of that section apply here.

At least two extra-regional circuits are needed in Traffic Model III. They are assumed to be destined to information centers in Europe.

5.5.3 Large Network

Figure 5.6 shows an example of a network which connects the 26 different center locations identified in Table 5.3.

With an average of 5 terminals per center the total bandwidth requirement is:

TABLE 5.3 Arab Region

Regional center

Egypt: Cairo

			Distance from regional center in km
National centers			
1	Egypt:	Alexandria	(150)
2	Lebanon:	Beirut	(530)
3	Syria:	Damascus	(570)
4	Jordan:	Amman	(460)
5	Iraq:	Baghdad	(1220)
6	Kuwait:	Kuwait	(1560)
7	Bahrain:	Manamah	(1870)
8	Oman:	Muscat	(2820)
9	Qatar:	Doha	(2000)
10	United Arab Emirates:	Abu Dhabi	(2230)
		Dubai	(2380)
11	Saudi Arabia:	Riyadh	(1560)
		Jidda	(1160)
		Mecca	(1220)
		Dharan	(1830)
12	Yemen Arab Republic:	San'a	(2020)
13	Yemen (P.D.R. of):	Aden	(2290)
14	Libya:	Tripoli	(1640)
		Benghazi	(1030)
15	Tunisia:	Tunis	(1960)
16	Algeria:	Algiers	(2550)
17	Morocco:	Rabat	(3350)
		Casablanca	(3450)
		Tangier	(3300)
		Marrakesh	(3510)

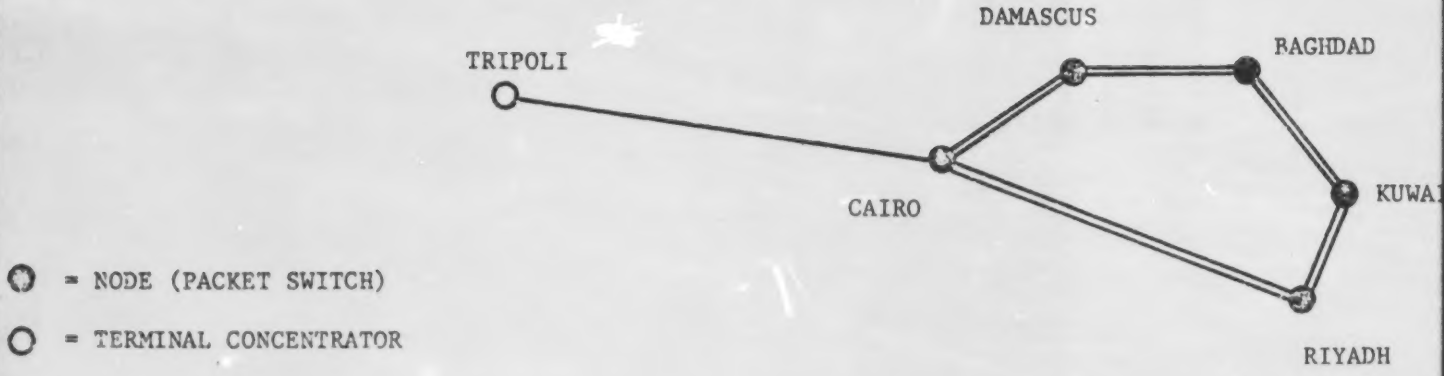


FIGURE 5.5

Arab region - small network

TRAFFIC MODEL	BANDWIDTH (bits/s) I	II, III
Interactive traffic		
- low/high estimate	1170/13390	2990/45110
- limit 100 bits/s/terminal	13000	13000
Batch traffic	2600-3120	8450-10400

In analogy with Section 5.3.2 the total bandwidth requirement is considered to be 13 000 bits/s for all traffic models.

Several of the connections in this network will use satellite links. The table in Annex III, which shows the transmission technology used on direct telephone routes at the beginning of 1975, indicates that radiotelephone circuits are in frequent use. Several new earth stations have been, or will be, taken into use within the region during 1975-1976. Consequently satellite links will be opened between many countries with previously poor international communication facilities. Expecting this development to continue, we have felt rather free to deviate from known existing telephone routes in the outlining of the networks.

In order to minimize response times, it is proposed that 9 600 bits/s is used for node-to-node connections wherever the circuit quality permits. This will give more than adquate traffic handling capacity compared with the requirements of the different traffic models.

We have calculated with four extra-regional circuits in Traffic Model III (two to Europe, one to USA and one to Iran).

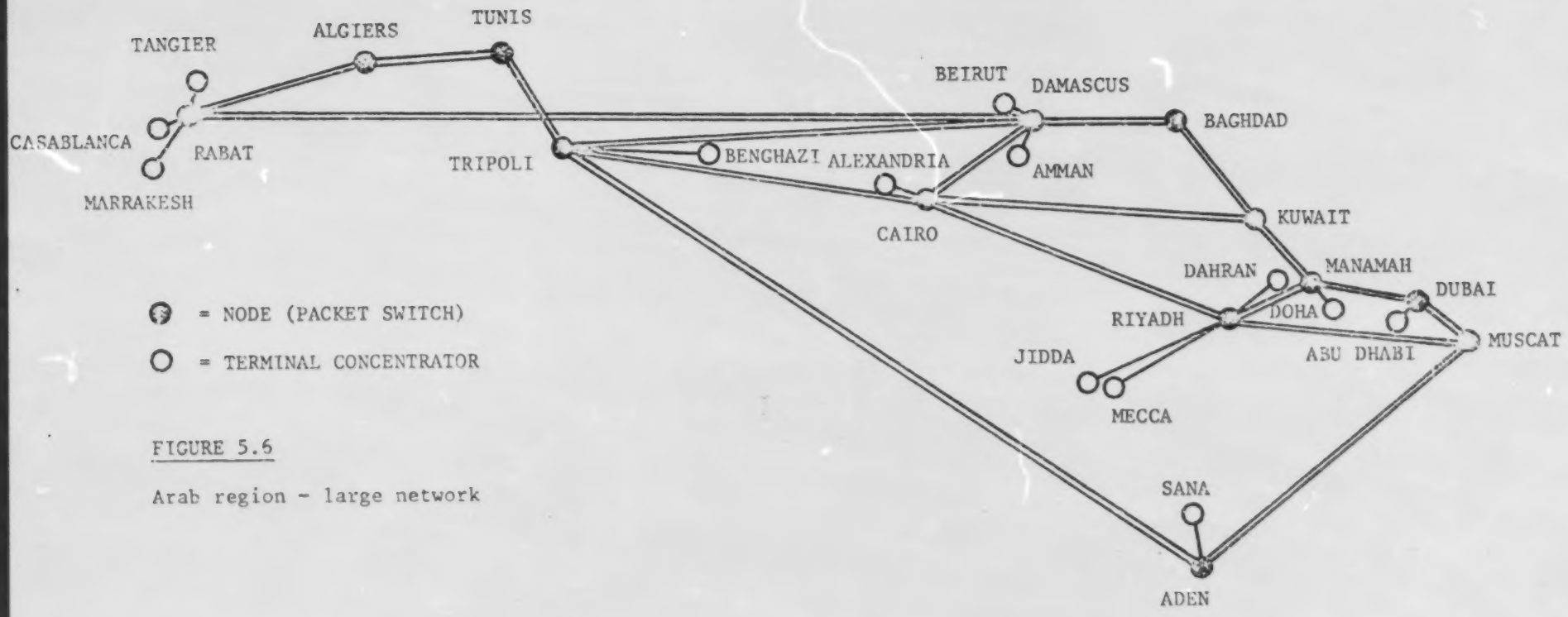


FIGURE 5.6

Arab region - large network

6 ECONOMIC CONSIDERATIONS AND COMPARATIVE EVALUATIONS

6.1 GENERAL

In this chapter the total annual costs for the different networks and traffic models are calculated and discussed.

The main cost items identified are equipment, lines, personnel and information centers.

Cost considerations related to local information retrieval centers are indicated for completeness in this chapter. The availability of different retrieval systems and data bases is abundant. Individual regional requirements, may vary considerably with consequent implications on operational costs. Information given here is intended only for illustrative comparison purposes.

6.2 EQUIPMENT AND LINE COSTS FOR THE NETWORKS

6.2.1 General

The annual costs of the regional networks defined in Chapter 5 are estimated on the basis of the equipment and line costs specified in Chapter 3 and Annex III. The annual equipment cost is calculated as 40% of the purchase price. This may be taken to represent a "worst case" situation as between 30 and 35% [1] may be more typical when written off over a 5 year period at 10% interest. Shorter amortization and higher interest rates may warrant the 40% figure. Maintenance cost may in some cases also be quite dominating. This depends often upon the type of equipment involved and the local conditions. The primary source for the line costs is the tables in Annex III showing practised charges. In cases where information is missing, we have filled in with qualified estimates based on charges for comparable connections in the same region or on charges derived from telephone tariffs as further described in Annex III.

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1) Annual amortization and interest 25%
Maintenance cost 5-12%
Possible rent of space and power 2- 5%

All in percent of purchase price.

We have based the calculations on an average of 5 terminals per center with an average purchase price of $ 4 000 per terminal. This corresponds to 50% typewriter terminals (30 characters/second) and 50% highspeed terminals with VDU and printer. The annual cost for 5 terminals and the lines connecting them to their center is 5 (0.4 · 4000 + 5000) $ = $ 33 000.

A variation from 3 typewriter terminals to 5 highspeed terminals per center corresponds to an annual cost variation between $ 17 400 and $ 35 000 per center.

For the cost calculations we have as a general rule assumed 2400 bits/s modems for lines between terminal concentrators and network nodes, and 9600 bits/s modems on node-to-node connections. The modem cost represent in general less than 5% of the cost for international circuits.

6.2.2 South East Asian Region

Breakdowns of annual communication costs for the small and large networks are shown in Table 6.1. The corresponding networks have been defined in Section 5.3.

Table 6.1 South East Asian Region. Breakdown of annual costs

Network:		Small		Large
No of centers:		6		18
Cost Category	No	Annual cost US $	No	Annual cost US $
EQUIPMENT				
Terminals	30	48 000	90	144 000
Terminal Concentrators (NC)	1	8 000	9	72 000
Network Nodes (NC,RC)	5	100 000	9	180 000
NATIONAL LINES (INCL. MODEMS)				
Terminals to NC	30	150 000	90	450 000
Concentrator to Node	-		8	96 000
INTERNATIONAL LINES (INCL. MODEMS)				
Concentrator to Node	1	12 000	1	109 200
Node to Node	5	741 600	12	1 878 000
EXTRA-REGIONAL LINES (INCL. MODENS) (only in Traffic Model III)	(2)	(537 600)	(4)	(883 200)
TOTAL, Mod I,II		1 059 600		2 929 200
Mod III		1 597 200		3 812 400

6.2.3 Andean Region

Table 6.2 shows the annual communication cost for the small and large network examples in the Andean Region as defined in Section 5.4.

We have only limited information on practised charges. The data we have indicate, however, a rather homogenous tariff level for the intra-regional traffic with charges in the range $ 100 000 to $ 15 000 per month and circuit. The charge is in general the same to all other South American contries with some exceptions for neighbouring countries. This may depend on the use of satellite links for most of the international circuits.

For the purpose of a total cost estimation we have made the simplifying assumption that the average montly charge is $ 13 000 each for those international circuits with unknown practised charge levels.

The cost for extra-regional circuits are similarily estimated to $ 20 000 per month and circuit.

Table 6.2 Andean Region. Breakdown of annual costs

Network:	Small		Large	
No of centers:	6		16	
Cost Category	No	Annual cost US $	No	Annual cost US $
EQUIPMENT				
Terminals	30	48 000	80	128 000
Terminal Concentrators (NC)	2	16 000	9	72 000
Network Nodes (NC,RC)	4	80 000	7	140 000
NATIONAL LINES (INCL. MODEMS)				
Terminals to NC	30	150 000	80	400 000
Concentrator to Node	-		6	72 000
INTERNATIONAL LINES (INCL. MODEMS)				
Concentrator to Node	2	332 400	3	447 600
Node to Node	4	528 000	9	1 194 000
EXTRA-REGIONAL LINES (INCL. MODEMS) (only in Traffic Model III)	(2)	(489 000)	(3)	(734 400)
TOTAL, Mod I,II		1 154 400		3 188 000
Mod III		1 644 000		3 922 400

6.2.4 Arab Region

Table 6.3 presents a breakdown of annual costs for a small and a large network as defined in Section 5.5.

The available information on practised charges for leased circuits within the region is sparse. To a great extent we have therefore relied upon the hypothetical charges derived from telephone tariffs for the cost considerations. In a few cases qualified estimates based on comparisons with similar circuits within the region have been used.

The costs for extra-regional circuits show considerable variation. Comparatively low charges are applied between Europe and some of the countries in North Africa.

The charges for circuits between Europe and the regional center (Cairo) are, however, on the same level as is normal for inter-continental relations, i.e. above $ 20 000 per month. As an general estimate of the cost per extraregional circuit, $ 22 000 per month has been used.

Table 6.3 Arab Region. Breakdown of annual costs

Network:	Small		Large	
No of centers:	6		26	
Cost Category	No	Annual cost US $	No	Annual cost US $
EQUIPMENT				
Terminals	30	48 000	130	208 000
Terminal Concentrators (NC)	1	8 000	13	104 000
Network Nodes (NC,RC)	5	100 000	13	260 000
NATIONAL LINES (INCL. MODEMS)				
Terminals to NC	30	150 000	130	650 000
Concentrator to Node	-		9	108 000
INTERNATIONAL LINES (INCL. MODEMS)				
Concentrator to Node	1	8 800	4	177 600
Node to Node	5	672 000	18	2 376 000
EXTRA-REGIONAL LINES (INCL. MODEMS) (only in Traffic Model III)	(2)	(537 600)	(4)	1 075 200
TOTAL, Mod I,II		986 800		3 883 600
Mod III		1 524 400		4 958 800

6.3 OPERATIONAL COSTS

For each communication network there will be a need to assign personnel with the following tasks:

- supervision and administration of the daily operations
- initiating repair and recovery of operations in failure situations
- system and software maintenance
- network development, functional as well as physical.

A network covering 6 centers will need 6-10 persons at a central location to handle the common administration, maintenance and development. 3-5 of these will need to be computer and telecommunications professionals with university level education. They should among themselves have systems expertise, as well as software and hardware specialists. The other members of the central staff are needed for management and other administrative tasks. The total size of the central staff will depend on the network size and the rate of network development.

At each national center there should be a technician, preferably an electrical engineer by training with knowledge of minicomputers and telecommunications.

As previously indicated the hardware maintenance cost is calculated into the cost of hardware. This assumes that the supplier has a maintenance organization in the region. Certainly, the local teleadministration will undertake the service and maintenance of modems and lines. Often times the service of terminal equipment can also be undertaken by the service organization of the teleadministration.

The above mentioned resources will be needed for the operations of the communication facilities. Additional staff will be required for the operation and maintenance of IR-systems and data bases.

Regional computer centers will of course also need the normal operational staff but the cost for this is assumed to be included in the computer cost, as indeed may be the case when for example a service bureau is used.

As stated in the introduction to this report, we do not have sufficient insight in regional salary levels. We shall therefore refrain from converting the manpower estimates to monetary units.

6.4 INFORMATION CENTER COSTS

The costs associated with the operation of a computer center for information retrieval can be fairly well estimated on the basis of experiences from many existing centers. It will of course depend on the type of computer and IR-system used, on the sizes of the installed data bases and on the need for local conversion of the data bases.

A detailed penetration of these factors fall outside the scope of this study and may be the subject of a separate investigation. We have, however, made an approximate estimate of the magnitude of costs and problems involved in establishing a regional information retrieval center. This appears as Annex IV.

The annual hardware and software cost for a computer installation, with sufficient capacity for Model I requirements (100 000 references), is in the order of 0,6 to 0,7 M$ annually. The corresponding cost for Model II (1 000 000 references) is 0,8 to 0,9 M$. The fee for data base utilization is not included in these costs. It will presumably be independent of whether a regional or an extra-regional information center is used. An indication of the personnel requirements is given in Annex IV. We have however refrained from expressing personnel and building costs in monetary units, as they may depend very much on local conditions.

It is noteworthy that the ten-fold increase of data base volume between Model I and Model II gives only a moderate increase in computer costs. This indicates that a better economy may be achieved with the larger center size.

6.5 COMPARATIVE EVALUATION

6.5.1 Comparison of different models

The analysis and design considerations lead us to propose identical networks for the traffic models I and II. The explanation for this is to be found in that the traffic capacity requirements are moderate in both cases. The dominant parameter determining the cost is instead the number of countries, or international links, involved.

With a given geographical coverage by the network, it is thus desirable to increase the number and size of data bases that are made available over the network. In this way a better utilization of the expensive lines may be achieved, resulting in a lower communication cost per search.

Models II and III differ with regard to the location of the computer center for information retrieval. In Model II this is associated with the regional center, while Model III assumes communication with extra-regional information centers. The requirements and costs for the regional communication network is found to be the same in both cases. Thus the cost of operating a regional information center should be compared with the cost of using corresponding services at extra-regional centers plus the cost of the required extra-regional lines.

It can be noted that the annual cost for an extra-regional line is in the order of $250 000. When this cost is compared with the cost of information center operation (Section 6.4), it appears likely that regional information centers will be a competitive alternative in many cases. This is especially to be expected for data bases with contents of mainly local interest for a specific region.

Large general data bases, already available at extra-regional information centers, can normally not be economically duplicated on a regional level. If they are frequently utilized, however, one may consider to hold the most recent references on a regional computer, at least for SDI purposes.

6.5.2 Comparison of different network sizes

An analysis of the relation between size (number of centers) and total cost for the communication network will show that the cost per center is not very strongly affected by the network size for traffic models I and II. (The average number of links per node is larger in the larger networks. On the other hand, there are in the large networks several centers, which are connected to network nodes by national instead of expensive international lines.)

Consequently, no significant gain in intra-regional communication costs can be expected, when the network grows to include more countries. Larger networks will however allow the costs of regional information centers and extra-regional lines to be shared by more users. This will contribute to a lower total cost per user in large networks than in small ones. Alternatively, a large network can provide more services to its users than a small network for the same total cost per user.

6.6 ECONOMY OF PACKET BROADCASTING

It may be of interest to explore to some extent the economic prospects of a solution based on packet broadcasting via satellite.

For this purpose we have chosen to use the small and large South East Asian networks as examples. The application of packet broadcasting in these networks could mean that each network node (packet switch) was equipped with a small local earth station. All leased circuits for node-to-node connections would thus be replaced by a shared satellite channel.

If extra-regional information centers also were equipped with a local earth station, the extra-regional leased circuits could also be removed.

The annual costs of leased international circuits in the small and large South East Asian networks are, according to Table 6.1:

Circuits	Small Network	Large Network
Node to node	741 600 US$	1 878 000 US$
Extra-regional	537 600 US$	883 200 US$
	1 279 200 US$	2 761 200 US$

The annual cost per node for space segment and earth station with interface minicomputer in a packet broadcasting network with 10 nodes, and satellite channel capacity in the range 100 to 1 000 kbits/s, has been estimated to be in the order of $15 000 to $40 000 (ERIC 75). Applying these values to the South East Asian networks, yields a total cost for the node-to-node links and the extra-regional links of $105 000 to $280 000 for the small network, and $195 000 to $520 000 for the large network. It should be stressed that these figures are based on "wholesale" tariffs for satellite capacity, domestically in USA. If this kind of operation is made possible on an international level, other tariffs may be applied. It appears, however, that a potential for drastic cost reductions exists for this kind of networks if packet broadcasting technique can be employed.

7 SPECIFIC INFORMATION NETWORK PROBLEMS AND SUGGESTED SOLUTIONS

This chapter deals with some problems of particular importance to information retrieval networks. Although not unique to this particular application, the problems of interfacing different information retrieval systems, computers and terminals are more conspicuous in the retrieval environment. This is coupled with the problem of man - machine interface and need to unify and simplify command languages for systems (or network) operation as well as in search and retrieval applications.

7.1 INTRODUCTION

Regional centers may be gateways to major centralized information retrieval systems with a large number of data bases. Examples of such systems are ORBIT and DIALOG from SDC respectively Lockheed of California, USA, and RECON from ESA in Italy. Furthermore, information retrieval systems and special purpose data bases may be available within the region or at the Regional Center itself. The information retrieval system used in the local application will most probably be different from the ones used in ORBIT, RECON and DIALOG, as indeed some of these systems themselves are dissimilar.

The different procedures for logon, network as well as search commands between the various systems are difficult, if not impossible, to remember and keep apart even in the case of well trained information specialists of long experience. The heterogeneity of systems of this type is therefore a problem of considerable importance. As also large sums of money are invested in the various systems and data bases, there appears to be little hope that these differences are going to disappear within short.

As important as the creation of an uncomplicated logon procedure and an easily learned and understood search command language, is the need for controlled access and accounting procedures in these systems.

There are a number of additional requirements that should be met for an information system to satisfy its users. These requirements will

be listed in the following chapter. It is important to note however that our requirements, as well as the environment and technology, the IR-systems, and the data bases themselves, change continually. Tomorrow will thus pose additional demands and the most important feature of a system is therefore its flexibility to adapt to the changed conditions.

It may be desirable, or in some cases essential, to provide a unified approach and simplified methodology to information system usage within a given region. Such approach will be furthered through the use of local regional systems with capacity to satisfy one or more of the requirements listed in the following chapters. This system with its monitor as well as the auxiliary functions may be provided by means of minicomputers or as resident programs of other host computers attached to the regional network. The functions may be introduced as demand arises. It is however essential that a facility for communication with the system, its monitor and associated functions is taken into consideration when the network is originally defined.

7.2 REQUIREMENTS

7.2.1 Human Factors and Interfaces

It should be recognized that most of the people who will use information retrieval systems are not necessarily technically trained, nor can they be assumed to have previous experience of computer terminals. In fact, some individuals that today have difficulties with national and international direct telephone dialling, may become users of tomorrows terminal based information systems. We know that todays procedures to establish on-line access to any computer system are complicated to say the least. We also know that they need not be, and moreover, that the computer itself can be used to bridge most of the difficulties encountered. The log-on and dialog languages must be simplified and brought up to a natural language level. It is also necessary that an assistance, or "help", function be part of the system. Thus no matter in what part of the retrieval process a user is, it should always be possible, by keying in the character "?" or typing "help", to get as detailed instructions as required to proceed to the subsequent step and desired result in the process.

7.2.2 Resource identification and allocation

In any system consisting of a number of subsystems, all of which are autonomous and of defined capability, it is necessary to keep track of the availability and indicate the limitations and particular conditions that apply when using the subsystem.

This is a necessary part of the system as well as a service to the user. It is of the same type as the help or assistance function previously described but at a different level. Examples of this type of resource identification are:

Subsystems and databases available

Natural language used in individual databases

Translational assistance available

Search Command Language used etc.

7.2.3 Security

The possibility to enable controlled and restricted access to different files and portion of files (databases) of a generalized information retrieval system is of considerable importance and should not be overlooked or deemphasized.

The positive identification of the user and the terminal, and where appropriate, a control that the identification is correct, is essential. As important is of course the check on user authority to access the files requested and immediate registration of misuse.

With regard to the access control system it is to be noted that such a system should be hierarchial. A mere level type of system is not satisfactory, no matter how many levels are possible.

7.2.4 Accounting and Statistics

Whether it is purely for purposes of apportioning the system cost or exclusively for statistical purposes, suitable methods for accounting and statistics are vital. In most cases the motives for use turn out

to be a combination of both of above purposes. In particular, statistics on the use of any function is of vital importance when assessing the importance of various facilities. Thus in the dynamic initial states and when facing future reorganization decisions, statistics may appear to be the most important, whereas accounting takes over this role in the steady state condition.

7.2.5 Retrieval Command Language

Although similar in many respects, the command languages used by different autonomous subsystems are sufficiently different to warrant special actions. The simplest alternative available is of course to make a note of the difference when describing the resource as available.

A more sophisticated approach is to provide a translational facility. In this way a general system language may be used for retrieval commands and individual translations passed on to the autonomous subsystems as required.

7.2.6 System Command Language

An extension of the requirements for a general Retrieval Command Language is the requirement for a uniform command language for the information system. Such a language, called System Command Language, would include commands for handling communications and "log-on"-procedures in a simple and uniform way. Commands controlling the identification and allocation of resources would also be parts of this language.

7.2.7 Synonym/Thesaurus or Translation Assistance

In many instances the natural language of the information searcher is different from that being used in the database. This may not present a general limitation to the use of any given database. However, a few specific words or their synonyms may not be known to the searcher. In such instances practical computerbased dictionaries or thesaurus functions as a part of the information system may prove to be of invaluable help.

7.3 A DISTRIBUTED SOLUTION

Consider for a moment the possibility of augmenting an existing IR system by the introduction, between the user and the IR system, of a computer program doing the required translating, emulating or table-look up function, as shown in figure 7.1. If the speed of this augmenting program were such that the delay introduced only negligibly added to the normal response time, the user would view the augmented result as an improvement in the original IR system itself.

All of the system requirements listed in the Section 7.2 may in fact be satisfied by augmenting functions as shown in Figure 7.1. An analysis of the delays introduced by the approach has shown these to be negligible compared to the transmission and search delays normally encountered[1)]. For each additional feature, or requirement, as listed in the preceding, a program may be added between the user and each information retrieval system.

A systematic approach to a system according to this concept could be as shown in Figure 7.2. Here a number of augmenting functions are shared by a number of users and IR applications. Each augmenting function being timeshared between the individual users and applications. To achieve the desired result, a supervisory monitor function will be required as well. In Figure 7.2 this supervisory function has been labelled System Monitor. It will be found, that in a practical embodyment of the concept indicated in Figur 7.2, some auxiliary functions should be part of the System Monitor itself. Examples of such functions are for example Resource Availability and Allocation, Accounting and Statistics.

To successfully employ the communication network as an "Interface Connector" between the users, various information systems and the augmenting functions with associated System Monitor, this possibility should be recognized as the network is originally implemented. If the network is to be used exclusively for I&D purposes this may not be necessary as the augmentation need will always be there.

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1) Parallel work in this area has been done at NBS and MIT in the USA and at L M Ericsson in Sweden. For more detail see the references in the bibliography (MARC 74, MARC 75 A, MARC 75 B, ROSE 75, SEMS 74).

In an information retrieval application the Communication Network would pass immediate control to the System Monitor as soon as a terminal is activated. The monitor system will stay in dialog with the user until the user identity, security level and requirements are established. At this time the System Monitor will determine "which of" and "desirable sequence of" augmenting functions required for this user, and establish such a route through the network. Each message will then pass through the desired augmenting functions before arriving at its destination. Clearly, these functions may be different with regard to number as well as type of service for the different directions of transmission. The System Monitor is called in when the user wants the dialog to terminate or affect changes in status.

Although all auxiliary programs including the supervisory System Monitor could be implemented in one major computer attached to the network as a host, a distribution of the tasks among a maxi- and one or more minicomputers dedicated to this purpose may be advisable. The latter approach may keep the delays on a negligible level and permit a stepwise augmentation not jeopardizing the network function on an occasional computer failure.

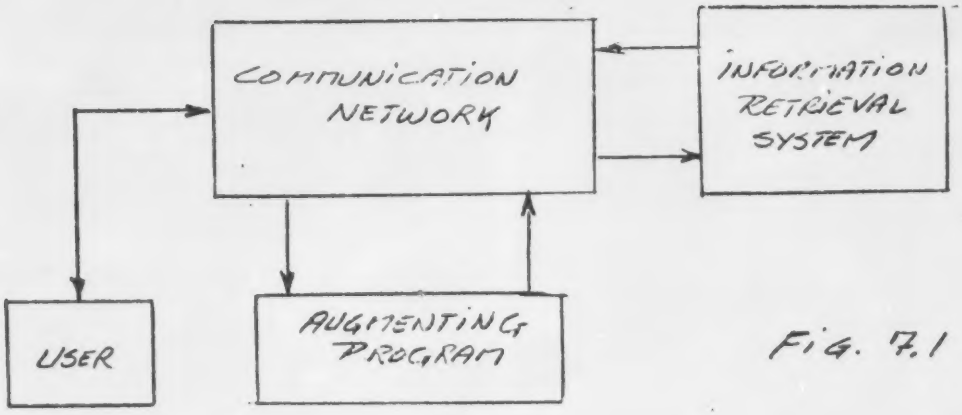
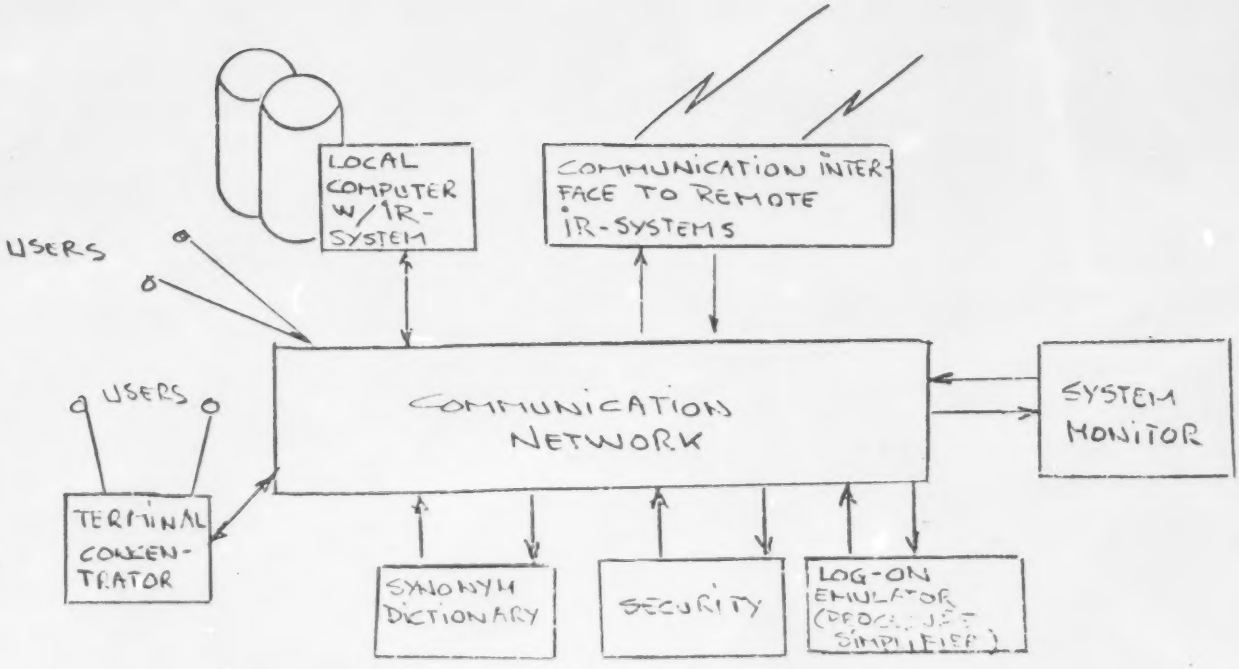


Fig. 7.1



AUGMENTING FUNCTIONS.

Fig. 7.2

8 CONCLUSIONS AND RECOMMENDATIONS

8.1 GENERAL

In summing up the results of this study, we will first repeat some of the most important observations made in the previous chapters and in the annexes. Secondly, a way to proceed in a stepwise manner, towards the establishment of useful regional and global information networks, is outlined.

Finally, some areas, where further studies or other activities are most urgently required, are indicated.

8.2 OBSERVATIONS

8.2.1 Usage of Networks

The cost of the communication network is dominated by the cost of international lines. Consequently, it is important to make best possible use of these lines. There are two aspects of this issue. The first is that the effective data transfer capacity of each line should be maximized. This is accomplished by the use of high speed modems and efficient traffic concentration methods. Secondly, the data transfer capacity should be used as effectively as possible. In other words it should be used to satisfy the important needs of as many users as possible within each of the countries connected to the network. This will broaden the economic base for each country's international links. The usage of the network can, by means of example, be increased by the following measures:

- Increase of the number of access points in each country.
- Increase in the number and coverage of data bases available for bibliographic information retrieval via the network.
- Expand the types of services to include matching of the retrieved references against files with information on where the full documents are held. The possibility of delivery of the complete documents via facsimile should be considered.

- Use the networks as inputting facilities for the generation of regional information data bases.

8.2.2 Network Design

Distributed networks have considerable advantages as they can be made less vulnerable and more flexible than centralized networks. They will enable connection of many different local resources to the network, and thus serve as a valuable infrastructure for international information exchange.

Due to the high line costs, the selection of good network topologies will be of considerable economic importance. As traffic estimates necessarily are uncertain, the emphasis should be on high flexibility rather than capacity optimization.

The response time characteristics will be of vital importance in the final evaluation of different network designs. This is especially so when the bit rates are limited to 2 400 bits/s or when multiple satellite links are included in a connection.

In order to limit development costs and enable a rapid introduction and usage of the networks, these must to the fullest possible extent make use of previously developed and proven systems technology.

In a longer perspective, and for the larger networks, the use of packet broadcasting technology should be seriously considered. This method will yield considerable advantages with regard to economy as well as performance. In particular the response time characteristics may be improved by this technique. The issue of response time in the packet broadcasting case needs to be further explored, however, before any conclusive statements are made.

8.2.3 Regional vs. Extra-Regional Information Centers

In the long time perspective a combination of regional and extra-regional information centers appears desirable in order to provide economic access to a large variety of data bases.

Data bases produced within the region and available on existing regional host computers should of course be connected to the regional networks. Other, frequently accessed data bases may also be economically installed in each region, at least for SDI or current awareness services. It will however be more economic to use telecommunication to extra-regional information centers for use of very large data bases or data bases which are less frequently used.

The choice of initial solution may to a large extent depend on institutional conditions within each region. It is however felt that the establishment of extra-regional links to major information centers, or connections to existing international networks providing such access, will be required at an early stage as a fast way of providing desired services.

8.3 STEPS TOWARDS REALIZATION OF THE INFORMATION NETWORKS

The realization of international information networks of the kind considered in this report, will necessarily require clarification of many specific regional conditions and negotiations with many involved parties. The priorities affixed to different services and geographical locations, as well as the budgetary constraints, will of course also determine the way and speed of implementation.

From chiefly a technical point of view the following steps in the developed process have been identified:

PHASE I

Establish a small scale network with nodes in 3 to 6 countries in the region. Use technology imported from for example EURONET or SCANNET. Set up links to one or two extra-regional information centers and connect existing or separately established information centers within the involved countries to the network.

PHASE II

Expand the regional services in accordance with the experiences from PHASE I. Extend the network coverage by installation of additional

nodes or terminal concentrators. Arrange inter-connections to other international networks with data bases, as for example EURONET, TYMNET, ARPANET or others.

PHASE III

Convert the communication network to make use of packet broadcasting via satellite, assuming the regulatory problems have been solved. Establish a global "high-level" network which interconnects the regional networks and major extra-regional information centers. Extend services to include facsimile delivery of full documents. Extend the regional networks to full coverage of each region and connect additional local resources to the network.

8.4 FURTHER STUDIES

Annex I includes a report on a study of the role of human intermediaries in the information retrieval process. Hitherto most experience is with the intermediary in the same room as the user. It may be of value to be able to request assistance of human intermediaries via the network. Further studies will be needed in order to find suitable methods for this.

The problems addressed in Chapter 7 also concern the interface between the user and the information retrieval system. Development of some of the augmenting functions mentioned are already under way, but this is certainly an area where more studies and practical experiments will be required.

Annex II gives a more general overview over development issues concerning the interface between computers and human beings. Studies of most of the points mentioned there will be of benefit for the development of information networks.

A recurring theme of this report has been the potential advantages which are believed to be offered by the use of the satellite packet broadcasting technology. The technical issues will probably not lead

to any major difficulties, but there is an obvious need to clarify and agree on the principles for the application to international interworking.

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ANNEX I

CURRENT EXPERIENCES OF IR SYSTEMS OPERATIONS

by

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CURRENT EXPERIENCES OF IR SYSTEMS OPERATIONS

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1 BACKGROUND

The past ten years have seen the development of a large number of bibliographic information retrieval centers. These centers developed in colleges and universities, industrial and commercial businesses, and governmental agencies. Some were developed only, or primarily, for the host organization while others were developed to service a wide spectrum of users.

The search systems developed by these centers generally fall into two classes: on-line or batch. In on-line centers, the bibliographic files are maintained on-line to the computer and the search system provides direct interaction with these files via on-line terminals. Typically, the files are inverted (i.e., an index or indices to the files are maintained) which allows a reference in the files to be retrieved without first examining every preceding reference. In batch centers, the files are generally kept off-line and searches are performed via a batch computer run. Typically, search requests or profiles for many users are included in the batch run, and the bibliographic files are searched in a sequential fashion. Many batch centers do, however, provide on-line entry and maintenance of profiles.

Bibliographic searches also fall into two categories: current awareness (or SDI) and retrospective. Current awareness searches provide at regular intervals a list of current bibliographic references that cover a user's area of interest. These references are retrieved, typically, from magnetic tape prepared and distributed by data base suppliers on a regular basis, and containing up-to-date bibliographic references comparable to those found in abstracting and indexing periodicals. Retrospective searches are generally in-depth searches performed over all or part of the total accumulated file. Retrospective searches tend to be one-time searches, whereas current awareness searches are continuing ones.

INTERMEDIARIES

An intermediary is available as part of the interface between the user and the search system for virtually every search center in the United States. The intermediary may be a reference librarian, subject specialist, or person with broad knowledge of the contents of the data bases available and the search system in use. The role of the intermediary includes assisting the user in clarifying the request statement, in selecting search terms, in formulating the search strategy, and in constructing the profile. In many centers the intermediary actually constructs the entire profile for the user. Another very important role of the intermediary is to provide tutorials on administrative procedures, search strategies, profile construction, data base content, and search system operation.

During 1974-75 the University of Georgia and UCLA conducted a study, sponsored by NSF, of the user interface in a bibliographic search center. One aspect of this study was to tape record a large number of user intermediary sessions (or interviews), and then to analyze these recordings. The following text was taken from the final report to NSF (see ref.):

"Of primary interest in the interview dialog analysis were the respective roles and interactions of the user and the intermediary. Invariably, the intermediaries asked questions which sought to clarify the subject scope of the question, the only exceptions being very simple one or two term search requests. An inspection of the questions and profiles suggested that the decision not to pursue question clarification was probably a function of the terms (vocabulary) provided by the user (e.g., names of specific chemical substances), rather than the simplicity of the question structure per se. Changes in scope which ensue from intermediary intervention are believed to result primarily from their knowledge of the coverage of the data bases or their knowledge of the vocabulary used in the data bases; personal knowledge of the subject matter of the question appeared to be a direct factor only infrequently. For a small, but important, percentage of the questions, the user independently inititated a change in the scope of the initial question, apparently as a result of the formalization of the information need during the interaction with the intermediary.

Other roles taken by the intermediaries during the interview are given in Figure 4, listed in descending order by frequency of occurrence. The roles occurring near the top of the list are what would be expected based on functions which are reported in the literature as being part of the negotiation process. Less expected was the relatively low involvement of intermediaries in vocabulary expansion and the profile coding techniques of truncation and Boolean logic formulation, both of which are given considerable attention in most profile coding manuals.

Roles	Percent
MAKES THE CHOICE (UNASSISTED) OF OUTPUT CONTENT	95%
ASSISTS IN SELECTION OF DATA BASES	56
SUGGESTS ADDITIONAL APPROACHES TO THE INFORMATION NEEDED	59
PROVIDES GUIDANCE ON VOCABULARY	55
PROVIDES GUIDANCE ON DATA BASE DOCUMENT COVERAGE	48
PROVIDES GUIDANCE ON INDEXING POLICY	43
ASSISTS IN QUESTION FORMULATION	39
EXPANDS SEARCH VOCABULARY FOR USER	34
ADVISES ON USE OF TRUNCATION	7
ADVISES ON SEARCH STRATEGY (LOGIC)	7

Figure 4. Roles Assumed by Intermediaries During Interview

Based on the results of the question-profile characterization (Task VII), two factors appeared to be affecting these results. First, the vocabulary expansion process appeared to operate somewhat differently, or at least to be conceived as different, for data bases which use thesaurus-based controlled indexing languages as opposed to those which depend on the natural (uncontrolled) language of titles and abstracts. For the controlled language data bases, the users selected search terms themselves directly from thesaurus, which

was not viewed as "vocabulary expansion". What was viewed as expansion of the vocabulary was the addition of alternate word forms, special coding conventions, and synonymous or closely related terms for the uncontrolled data bases. Moreover, much of this vocabulary expansion, as well as term truncation, occurred as a post-interview process (i.e., after the user left). Very little overt attention was placed on the Boolean logic expression per se during the interviews, although it was clear from the notations of the intermediaries on their worksheets and from the questions which they asked seeking clarification that the search strategy established during the question negotiation had been conceptualized in terms of the logic expression which would ultimately be used (e.g., assignment of group numbers to concepts and their associated terms plus the use of a shorthand notation of the group relationships). The formal Boolean logic statement, which is required for each profile, was frequently constructed following completion of the interview session with the user, however.

Returning to the roles of the intermediaries, they did provide explanations for a wide range of topics related to the search process: data bases and their corresponding vocabulary sources, general descriptions of the search procedure and of a profile, the process of revising profiles, the delivery schedule for search results, and, less frequently mechanics of the search process such as truncation, weighting, and logic expressions. As would be expected, explanations were provided far more frequently for new users than for experienced users. Also, the intermediaries provided explanations more frequently than they were specifically asked by the users for information about the same set of topics. Based on the transcribed interviews, the intermediaries appeared to be pre-empting some of the user's questions and also responding to misunderstandings or problems which became apparent during the interview, but the relative frequency was not investigated. The selection of search terms was clearly a joint effort between the user and the intermediary. Both suggested possible search terms in a large majority of the interviews but the user did the actual selection (or discard) in over 90% of the cases. The selection of the data bases to be searched also tended to be a combined effort (68% of the interviews), with the user and the intermediary taking the initiative in about equal proportions. And, as

was discussed earlier, development of the actual Boolean logic expression was predominantly an activity of the intermediary, with the user being asked for concurrency in only 16% of the interviews.

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One conclusion of this study is that the intermediary serves a necessary and vital role in the user interface. Some users do not, however, have trained intermediaries available to them. In addition, intermediaries indicate that sometimes they need assistance in areas such as profile construction, language features, and processing procedures. For these reasons, a systems specialist is proposed. The system specialist would have in-depth knowledge of the profile language, profiling aids, and data bases, and would have general subject knowledge. Where appropriate, several system intermediaries with more specialized subject knowledge could be used. The function of the system specialist would be to serve as a consultant and resource person for both users and intermediaries, and to serve as the primary intermediary for users (e.g., remote users) not having access to an intermediary. The method of communication between the specialist and the user could be through interactive terminal messages, via telephone, or, as is being experimented with by one existing center, via headphones to users at interactive terminals.

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The results of this study are believed to support the position that human intermediaries must be retained as an integral component of a network model, though not necessarily functioning in the same way as they now do. Specifically the human element is critical for the problem solving activities. The extent to which these functions can be performed on an exception basis, rather than as a part of the primary interaction mechanism, will depend entirely on the effectiveness of any automated diagnostic capabilities. „

It is our recommendation that the necessity and role of the intermediary in the proposed network be very carefully examined. Most experience is with intermediary in the same room as the user, and

there is very little data to guide one in choosing another alternative. Perhaps a separate study of this issue is warranted.

3 COMMUNICATIONS COSTS

The parameters of the bibliographic information retrieval (BIR) application which primarily determine communication costs, are as follows:

Circuit-switching	Packet-switching
Connect times	Average bandwidth
Peak bandwidth	Peak bandwidth

By "bandwidth" we mean the effective capacity in bits per second of the communication channel between computer and user terminal. Assuming on-line access via typewriter or display terminals, the peak bandwidth is presumably the rate at which output is presented to the user; in both rate and quantity, input is generally much less than output in the BIR application.

These parameters are affected by the speed of the terminals and the mode of user interaction provided by the BIR center, but not (directly) by the specific organizational or communication model which is chosen.

Our goal is to arrive at a reasonable estimate of the three cost-determining quantities (connect time, peak bandwidth, and average bandwidth). First, observe that there are likely to be several, in fact, four, distinct modes of terminal usage in a single on-line BIR session.

Mode 1: Interactive profile entry

The user interactively enters or modifies a previously-entered search profile. He may make simple typing errors as well as errors in syntactic Boolean expressions.

Mode 2: Intermediary Communication

As pointed out earlier, the typical user is going to require on-line help from a human intermediary. This mode can be characterized as a human conversation proceeding via typewriter.

Mode 3: Waiting for Processing

When the user had prepared a profile and requests a search, there will in general be a delay (which could be substantial) while the system performs the required processing. During this time, the terminal is assumed to stay connected but the communication link is idle.

Mode 4: Abstract Output

When the user has narrowed his search sufficiently, he will request that the full abstracts be typed/displayed on his terminal. This mode uses the peak output bandwidth.

Figure 3.1 shows results directly measured or reasonably inferable from such measurements, from two on-line BIR systems.

Experience with Communication Requirements of Some On-line Bibliographic Information Retrieval Systems

	Average Connect Time	Average Bandwidth	Peak Bandwidth	Average Total Characters
SDC	30 min	7.2 cps	30 cps(1)	13,000
ESA/ RECON	37 min	55 cps(2)	500 cps(3)	120,000(4)

(1) Determined by terminal speed

(2) Derived from estimated 120,000 characters over 37 minutes (see (4))

(3) Some user terminals include 300 lpm printers.

(4) Measured 116 items retrieved. If these were all printed, and each item was 1000 characters, result would be as shown.

Figure 3.1

4 CONNECT TIMES

Two different on-line BIR systems have measured remarkably similar values for average connect times (see Ref 1 and 2); both found that users stay connected approximately 30 minutes. From this measured figure, we need to project an average connect time for the proposed UNISIST BIR network.

The current experience has been based upon systems without on-line intermediaries. For example, SDC (Ref 1) provides services to a "retailer", a local library which has local intermediaries in-house. As we discussed earlier, we must assume remote, centralized, on-line intermediaries in the UNISIST system. Thus, we must project a time for Mode 3 operation, and add that time to the present 30 minute average.

It is our opinion that Mode 3 interaction will itself average 30 minutes, bringing the overall average connect time up to one hour per session. This assumption is admittedly subjective, based upon our feelings about human (im)patience. If the human dialogue exceeds the machine dialogue time, the user is likely to give up.

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ANNEX II

THE STATE-OF-THE-ART IN HUMAN COMPUTER COMMUNICATION: PROBLEMS AND ISSUES

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THE STATE-OF-THE-ART IN HUMAN-COMPUTER COMMUNICATION: PROBLEMS AND ISSUES

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1 INTRODUCTION

There have been a number of SOA (State-Of-the-Art) reviews over the years. They are usually organized topically, with discussions of the published work that seem to cluster under the particular topic. The following chapter reports some of the current ideas and work as it reflects upon the issues that have influenced the SOA. There are a number of issues concerning interactive computer based systems whose resolution will determine the nature of human-computer communication for the future.

2 MAN-MACHINE INTERFACE - DESIGN ISSUES

2.1 DEVELOPMENT OF CONSISTENT AND STANDARDIZED CONTROL LANGUAGES

Artificial and cryptic command words vs. natural words/vocabulary;

The computer-recognition-of-commands-scheme for user languages;

- What are the relative values of the different schemes ranging from line-at-a-time to full duplex, full command word echo?

Customization vs. standardization -- the options made available to the user;

- Should a wide range of options be available to users that can customize the interface, or should the characteristics of the interface be determined a priori for classes of users by the system designers?
- What are the important options that can be made available?

- Is it more appropriate, especially with novices or naive users, to have the system monitor the interaction and provide progressively richer alternatives to the user based on an automatically maintained profile? Is it or can it be cost effective to maintain such a profile?

The separation of the control language parser from the deep code in interactive software systems;

- The value of having the "front end" of an interactive system separated from the computer mainframe appears to have two important advantages;

  1 It permits the use of a standardized command language and interaction mode across kinds of applications, software languages, hardware, etc,.

  2 It can reduce cost and increase interactive performance.

  Is this value generally perceived, what is being done, and is it technically and economically feasible?

Multilingual control languages -- has anything been done?

- It appears that most interactive computer systems have been developed in English. What kinds of interactive systems have been developed in other languages and what would it take to convert a system for users in other countries?

2.2 DEVELOPMENT OF ALTERNATIVE MODES (NON-COMMAND LANGUAGE) OF INTERACTION

Is the use of language based interfaces demonstrably superior to alternative means of interaction, or should alternative methods be explored? A number of new alternative approaches can be expected.

Does it appear that these approaches are going to be significantly applied in the future, or are they merely interesting tangents?

2.3 DEVELOPMENT OF CONSISTENT AND STANDARDIZED TERMINAL/INTERFACE EQUIPMENT

What agreement is there about equipment design? What characteristics have been studied sufficiently to warrent the standardization, and what efforts are underway to promote it?

2.4 THE PARAMETERS OF TIMELY SYSTEM RESPONSE

How fast does control feedback (command echo in full duplex systems) about commands need to be received, and how responsive does the execution of commanded processes have to be? What are the criteria for evaluating responsiveness?

2.5 SHARED USAGE OF HETEROGENOUS COMPUTER FACILITIES

What are the present and future scenerios for access to multi-system environments?

2.6 POINTS OF VIEW -- COMMON CARRIER, NOVICES OR NAIVE USER, COMPUTER TECHNOLOGIST, DESIGNER, PROGRAMMER, ETC.

The SOA cannot readily be discussed unless recognition, at least, is made of the different perspectives (e.g., programmers, the non-technical applications community, manufacturers, etc.) and how these bias the view of different issues.

3 TECHNOLOGY TRANSFER PROCESSES

This often neglected area has increased importance and will become more vital as the emphasis within the computer technology community shifts toward applications from research and invention, due primarily to the lessening of funds for pure development.

The areas and issues;

User training (face-to-face) methods and strategies:

1 System access with a user manual ranging to off-line programmed instruction.

2 Initial training (introductory) and user manuals.

3 Training and supporting documentation, where training is the vehicle for transferring full capability.

4 Training and consultation to full capability, minimal dependance upon documentation.

Online vs. offline user training, documentation, and assistance;

- What are the varying degrees of effectiveness and cost of online assistance ranging from the listing of current alternative commands, through full text explanations and definitions to computer based instruction with "intelligent" question-answering capabilities?

The tradeoffs between the power and subsequent complexity of the computer system vs. simplicity and ease of learning;

- An increasingly vital question with the rapid advancement in software and hardware capability concerns the intersection of increased power, richness, capability, general purposefulness and decreased learnability, transferability and trouble free opeation.

Interaction into daily working environments;

- In addition to the factors of training, complexity, etc., what is important to the successful acceptance by a user population (e.g., management support, involvement of the users in the decisions, full explanation of pertinent plans, goals and expectations, etc.)?

Public acceptance;

- What are the important factors beyond those concerning the immediate implementation environments, such as cultural and educational elements?

4 IMPACT ON INDIVIDUALS AND ORGANIZATIONS

4.1 METHODOLOGIES FOR ASSESSING IMPACT

4.1.1 Psychometric -- experimentally controlled (laboratory simulation)

Attitudinal, controlled scaling.

Interface analysis;

- Human factors variables such as transaction error count (e.g., incorrect commands/time).
- Information flow process analysis.

  STM (Short Time Memory) and LTM (Long Time Memory) loading and interference factors (experimental/laboratory).

4.1.2 Sociometric -- representative sampling techniques

Efficiency;

- Production and manpower comparisons; traditional vs. computer augmented methods on the basis of throughput time and manpower required.

Case -- longitudinal.

Surveys of user populations.

Interviews of user populations.

Field observations.

4.1.3 Performance time and motion -- stopwatch type comparisons of performance, technique and procedure

Interface manipulation.

Use skills.

4.1.4 Software statistical -- quantification of automatically measurable usage variables, e.g.. Command usage count.

4.1.5 Data Base Analysis -- Feedback, message collections, etc

4.2 RELATIONSHIP BETWEEN DESIGN VARIATIES AND SOCIAL-PSYCHOLOGICAL EFFECT

What are some of the noteable examples of the application of these methodologies?

5 RESULTS-SHARING AND LITERATURE DISSEMINATION

What is the current emphasis on the incorporation of research results in all related disciplines, particularly the social sciences?

Who are some of the organizations and groups fostering results-sharing and literature dissemination?

ANNEX III

INTERNATIONAL LEASED CIRCUITS

by

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INTERNATIONAL LEASED CIRCUITS

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1 GENERAL

This annex contains information regarding cost and availability of international leased telephone circuits.

Conditions within the South East Asian, Andean and Arab regions are studied, as well as some extra-regional relations.

It is practically impossible to collect complete information on this subject. There is a great number of national administrations and international carriers involved using a variety of tariff structures. Several of the countries concerned have none, or very limited, experience of data communications. There is often no fixed tariff for international leased circuits, in which case the charge is calculated for each individual circuit. The practical technical possibilities and limitations with regard to circuit availability and quality are constantly changing.

Recognizing this, it has still been found worthwhile to assemble the information we have been able to collect to date.

It must be strongly emphasized that the conditions reported here are dynamically changing as a result of the introduction of new technology (for example satellite circuits) or as a result of policy decisions with regard to tariff levels and tariff structures. Whenever exact information is required, the actual conditions must therefore be checked with the concerned authorities.

2 CIRCUIT CHARACTERISTICS

2.1 TRANSMISSION TECHNOLOGY

Long distance telephone circuits using radiotelephone technology are still widely used, and a few countries rely entirely on this

kind of circuits for their international telephone traffic. The radio-telephone links are however in many cases being replaced by satellite circuits.

Coaxial cables or radio-relay links (microwave) with frequency division multiplex (FDM) transmission are commonly used to interconnect neighbouring countries. This technology is also used to bridge longer distances, as exemplified by the many existing and planned submarine cables.

The telecommunication satellites are being utilized at an increasing scale not only for intercontinental and long distance international relations, but also for rather short distances. Many countries are also incorporating satellite links in their national networks. This is especially attractive where geographical conditions make terrestrial links expensive. The current development of earth stations with small-diameter antennas will facilitate a much more widespread use of satellite circuits in the future.

The transmission quality for satellite circuits is very good and suitable for highspeed data transmission. A serious drawback is however the rather long propagation time involved. It is in the order of 0.27 seconds per hop in each direction. The loop-delay on a communication link will thus increase by about 0.54 seconds when it includes a satellite circuit.

2.2 DATA TRANSFER RATE AND MODEM COST

A leased telephone-type circuit can be specially conditioned to suit data transmission requirements. The CCITT has in its recommendation M.102 specified a set of characteristics which a thus conditioned circuit should be given.

Modern high speed modems for 9 600 bits/s include functions for adaptive equalization of the circuit characteristics, which makes M.102-conditioning superfluous. It is of course still necessary that the leased circuit is of good quality, but the equalizers inserted by the PTT to meet M.102 standard may in some cases interfere with

the equalizers in the modems and thus even worsen the final result. The achievable data transfer rate on leased voice grade circuits of good quality is 9 600 bits/s. On a switched telephone circuit of good quality, it is in general possible to transfer 2 400 bits/s with a tolerable error rate. As the quality of the switched network varies considerably between different countries, it may however at some locations be difficult to use it even for 1 200 bits/s. Modems

Modems for transmission of 9 600 bits/s over a telephone line are quite sophisticated pieces of equipment with a purchase price in the order of $6 000. Modems for 4 800 bits/s are priced at about $3 000, while a 2 400 bits/s modem can be bought for $1 500.

In some countries modems must be leased from the telecommunications administration. The resulting cost may then be different from the cost calculated on a basis of the above mentioned purchase prices.

3 CHARGES FOR LEASED CIRCUITS

3.1 GENERAL

In general the charge for an international leased circuit is based on one part determined by each terminal country plus one part for each of the transit countries. When a radio-telephone or a satellite circuit is used, the distance has little effect on the actual costs for the telecommunications administrations. Nevertheless the charges collected from the user may (in accordance with CCITT recommendations) be based on distance, applying the same scale of tariffs as for cable transmission systems. In other cases a system with fixed rate to all countries within the region is applied.

Other factors influencing the tariffs are national pricing and taxing policies. Countries with an overloaded telecommunications network may find it rational to apply high tariffs in order to refrain the demand and to finance improvements.

These and other circumstances contribute to the many irregularities that can be found in a study of the international tariff structure.

Several different sources have been utilized for the collection of tariff information.

The main sources are:

1) Information received through direct telex or telegram contact between members of Working Group 6.2 and national PTT:s. The efforts of H. Teramura are specially acknowledged.

2) Information collected by local L M Ericsson representatives in some countries.

3) Information deduced from ITU publications and CCITT recommendations (Ref. 1, 2).

4) Information from parts of the report "The World Telecommunications Directory 1975" published by Frost & Sullivan, Inc. (Ref 3).

A general reservation has to be made regarding the validity of the reported practised charges:

If a circuit is used for alternate voice and data transmission (AVD) or solely for data transmission, the CCITT recommends that the applied charge should be 25% higher than for circuits used only for voice communication. This rule is generally applied in Europe, but it is not clear to what extent it will be applied for the regional circuits.

Where separate tariffs are known to exist we have used the higher one for the tables.

3.2 PRACTISED CHARGES

Tables 1 to 6 show the monthly charge, expressed in US$, for international leased circuits within each region as well as for extra-regional circuits. The information originates, as mentioned above, from several different sources. Frequently, different sources report

different charges for the same relation. This can sometimes depend on the use of different currency conversion rates. In other cases it may depend on different assumptions with regard to circuit routing. By comparing and critically judging the collected information we have arrived at the results reported in the tables. In order to underline the uncertainty of these data, we have in general rounded off each value to at most two significant digits.

In some cases we only have information regarding the terminal charge for one of the countries (this is marked by parenthesis around the value in the tables). The total charge can then often be roughly estimated by doubling this value. If a transmit country is involved in the connection, the transit charge is normally, but not always, included in the charge stated by each terminal country.

3.3 HYPOTHETICAL CHARGES BASED ON CCITT RECOMMENDATIONS

The CCITT has in its D-series recommendations given guidelines for the determination of charges for leased international circuits. It is recommended that different charges should be applied for different uses of telephone-type circuits.

Recommendation D.2 is intended for application to circuits between terminal countries located in the same continent. The rental for monthly leasing of a telephone-type circuit "for all uses" is fixed on the basis of 9 000 minutes per month and, in the same way as for automatic telephone service, the accounting rate for the circuit may be multiplied by a variable coefficient of up to 1.8 to adapt the international tariffs to the national level of tariffs.

If the circuit is used solely for the exchange of telephone conversations or for "point-to-point" facsimile, the charge may be based on 6 000 minutes per month. If the circuit use is limited to "point-to-point" connections or to international networks for private use exclusively by the customer, the charge may be based on 7 500 minutes per month.

For the leasing of a special quality (M.102) telephone-type circuit it is recommended that each terminal administration makes an additional monthly charge of 600 gold francs, which corresponds to 236 US$.

As information on practised charges is missing for many relations of interest for this study, especially for the Arab region, we have for comparison included calculations of hypothetical charges based on charging rates for telephone conversations within the Arab region. We want to explicitly stress that this information may be irrelevant in many cases, as the actual tariffs are determined by the administrations on other grounds. This is evident from any comparison between the practised and hypothetical charges for the same circuit. The tables 7 and 8 showing hypothetical charges for the Arab region however be helpful as a first approximation, in those cases where the practised charges are unknown.

The hypothetical charge for a leased circuit is calculated as 7 500 times the charge per minute of telephone calls between the same points. Information on international telephone charges is derived from Reference 1.

Also this information is far from complete. There is no charging information at all for intercontinental routes, and information is also missing for many regional routes of interest for this study.

4 EXISTING DIRECT TELEPHONE ROUTES

Reference 1 lists the routes used for telephone traffic in the beginning of 1975. Also the type of link is indicated, i.e. cables or radio-relay system, radio-telephone circuit or satellite link.

For those relations where direct routes exist, the link types used for telephone traffic are shown in tables 9 to 11.

The following notation is used:

T = terrestrial link (cable or radio-relay system)
R = radio-telephone link
S = satellite link

It should be observed that parts of this information already may be obsolete, as new routes are taken into service. Several countries in the Arab region have for example planned to install new earth stations at the end of 1975 or the beginning of 1976.

5 REFERENCES

1 LIST OF INTERNATIONAL TELEPHONE ROUTES
15th edition (Position of 1st January 1975)
International Telecommunication Union, Geneva, 1975)

2 C.C.I.T.T.
FIFTH PLENARY ASSEMBLY
GENEVA, 4-15 DEC. 1972
GREEN BOOK, VOLUME II-A
The International Telecommunication Union, 1973

3 WORLD TELECOMMUNICATIONS DIRECTORY 1975, PART 2
Frost & Sullivan Inc, New York, 1975

B: / A:	MALAYSIA	THAILAND	SINGAPORE	INDONESIA	BURMA	PHILIP.	HONG KONG	KOREA	PAPUA	FIJI
MALAYSIA	860[1)]	(3 900)	900	(4 700)		14 000	14 000		13 000	20 000
THAILAND		-			9 000	15 000	16 000			
SINGAPORE	900	(4 700)	-	(4 700)	(7 100)	14 000	14 000	14 000	13 000	20 000
INDONESIA				-		17 000			23 000	
BURMA		9 000			-					
PHILIPPINES	14 000	15 000	14 000	17 000		-	9 600	17 000	12 000	18 000
HONG KONG	14 000	16 000	14 000			9 600	-	16 000	14 000	21 000
KOREA			14 000			17 000	16 000	-		
PAPUA NEW GUINEA	13 000		13 000	23 000		12 000	14 000			13 000
FIJI	20 000		20 000			18 000	21 000		13 000	

( ) = terminal charge for country A only

Notes

1) Kuala Lumpur - Penang

TABLE 1

TOTAL MONTHLY CHARGE FOR LEASE OF VOICE GRADE CIRCUITS (US$)

South-East Asian region / Intra-regional circuits

A: / B:	AUSTRALIA Sydney	NEW ZEALAND	JAPAN	CANADA Vancouver	USA San Fr	USA New York	VENEZUELA	UNITED KINGDOM	EGYPT	IRAN
MALAYSIA	20 000	20 000	20 000	27 000	27 000	28 000		27 000		
THAILAND										
SINGAPORE	21 000	21 000			22 000	23 000	28 000	21 000	21 000	21 000
INDONESIA										
BURMA										
PHILIPPINES	20 000	18 000	18 000	22 000	23 000	24 000		21 000		
HONG KONG	22 000	20 000	17 000	25 000	18 000	19 000		24 000		
KOREA			15 000							
PAPUA NEW GUINEA	14 000	13 000	20 000	27 000	26 000	27 000		26 000		
FIJI	13 000	13 000		19 000				21 000		

TABLE 2

TOTAL MONTHLY CHARGE FOR LEASE OF VOICE GRADE CIRCUITS (US $)

South-East Asian region / Extra-regional circuits

A: / B:	PERU	ECUADOR	COLOMBIA	BOLIVIA	VENEZU	PARAGUAY	CHILE	ARGENT	URUGUAY	BRAZIL
PERU	–				11 000					
ECUADOR		–			11 000					
COLOMBIA	(5 000)	(5 000)	–		8 400		11 000	(5 000)		(5 000)
BOLIVIA				–	11 000					
VENEZUELA	11 000	11 000	8 400	11 000	–	11 000	11 000	11 000	11 000	11 000
PARAGUAY					11 000	–				
CHILE 1)	(7 250)	(7 250)	12 000		11 000		–	(7 250)	(7 250)	(7 250)
ARGENTINA					11 000			–		
URUGUAY					11 000				–	
BRAZIL					11 000					–

( ) = terminal charge for country A only

Notes

1) AVD 9 600 bits/s

TABLE 3

TOTAL MONTHLY CHARGE FOR LEASE OF VOICE GRADE CIRCUITS (US $)

Andean region / Intra-regional circuits

A: / B:	AUSTRALIA	NEW ZEALAND	JAPAN	USA New York	UNITED KINGDOM	EGYPT	SINGAPORE	FIJI
PERU								
ECUADOR								
COLOMBIA						20 000	23 000	
BOLIVIA								
VENEZUELA						20 000	23 000	
PARAGUAY								
CHILE								
ARGENTINA					15 000			
URUGUAY								
BRAZIL					17 000			

TABLE 4

TOTAL MONTHLY CHARGE FOR LEASE OF VOICE GRADE CIRCUITS (US $)

Andean region / Extra-regional circuits

A: / B:	EGYPT	LEBANON	SYRIA	JORDAN	IRAQ	KUWAIT	BAHRAIN	OMAN	QATAR
EGYPT	-	(7 700)	(3 800)	(7 700)	(7 700)	(7 700)	(7 700)	(7 700)	(7 700)
LEBANON		-							
SYRIA			-						
JORDAN				-					
IRAQ	(4 800)	(4 800)	(4 800)	(4 800)	-	(4 800)	(4 800)	(4 800)	(4 800)
KUWAIT						-			
BAHRAIN							-		
OMAN								-	
QATAR									-

( ) = terminal charge for country A only

TABLE 5 -A

TOTAL MONTHLY CHARGE FOR LEASE OF VOICE GRADE CIRCUITS (US $)

Arab region / Intra-regional circuits

A: / B:	UN ARAB EMIRATES	SAUDI ARABIA	YEMEN A.R.	YEMEN (P.D.R. OF)	LIBYA	TUNISIA	ALGERIA	MOROCCO
EGYPT	(7 700)	(7 700)	(7 700)	(7 700)	(3 800)	(7 700)	(7 700)	(7 700)
LEBANON								
SYRIA								
JORDAN								
IRAQ	(4 800)	(4 800)	(4 800)	(4 800)	(4 800)	(4 800)	(4 800)	(4 800)
KUWAIT								
BAHRAIN								
OMAN								
QATAR								

( ) = terminal charge for country A only

TABLE 5 -B

TOTAL MONTHLY CHARGE FOR LEASE OF VOICE GRADE CIRCUITS (US $)
Arab region / Intra-regional circuits

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B:	EGYPT	LEBANON	SYRIA	JORDAN	IRAQ	KUWAIT	BAHRAIN	OMAN	QATAR
A:									
UNITED ARAB EMIRATES									
SAUDI ARABIA									
YEMEN ARAB REP									
YEMEN (P.D.R. OF)									
LIBYA									
TUNISIA									
ALGERIA									
MOROCCO									

TABLE 5 -C

TOTAL MONTHLY CHARGE FOR LEASE OF VOICE GRADE CIRCUITS (US $)

Arab region / Intra-regional circuits

B:	UN ARAB EMIRATES	SAUDI ARABIA	YEMEN A.R.	YEMEN (P.D.R. OF)	LIBYA	TUNISIA	ALGERIA	MOROCCO
A:								
UNITED ARAB EMIRATES	-							
SAUDI ARABIA		-						
YEMEN ARAB REP			-					
YEMEN (P.D.R. OF)				-				
LIBYA					-			
TUNISIA					(3 200)	-	(3 200)	(3 900)
ALGERIA							-	
MOROCCO								-

( ) = terminal charge for country A only

TABLE 5 -D

TOTAL MONTHLY CHARGE FOR LEASE OF VOICE GRADE CIRCUITS (US $)

Arab region / Intra-regional circuits

A: / B:	AUSTRALIA	JAPAN	USA	VENEZUELA	UNITED KINGDOM	ITALY	IRAN	SINGAPORE
EGYPT	(11 000)	(11 000)	(11 000)	20 000	(11 000)	(11 000)	(11 000)	21 000
LEBANON								
SYRIA								
JORDAN								
IRAQ	(14 000)	(17 000)	(14 000)	(17 000)	(10 000)	(10 000)	(4 800)	(17 000)
KUWAIT								
BAHRAIN								
OMAN								
QATAR								

( ) = terminal charge for country A only

TABLE 6 -A

TOTAL MONTHLY CHARGE FOR LEASE OF VOICE GRADE CIRCUITS (US $)

Arab region / Extra-regional circuits

A: / B:	AUSTRALIA	JAPAN	USA	VENEZUELA	UNITED KINGDOM	ITALY	IRAN	SINGAPORE
UNITED ARAB EMIRATES								
SAUDI ARABIA								
YEMEN ARAB REP								
YEMEN (P.D.R. OF)								
LIBYA						6 000		
TUNISIA						3 700		
ALGERIA								
MOROCCO					4 200			

TABLE 6 -B

TOTAL MONTHLY CHARGE FOR LEASE OF VOICE GRADE CIRCUITS (US $)

Arab region / Extra-regional circuits

A: / B:	EGYPT	LEBANON	SYRIA	JORDAN	IRAQ	KUWAIT	BAHRAIN	OMAN	QATAR
EGYPT	-								
LEBANON		-							
SYRIA		990	-	2 100	6 900	11 800	18 100		21 300
JORDAN				-	12 600	12 600	12 600		
IRAQ			6 900		-	9 600	12 700	15 800	15 800
KUWAIT		13 300	13 000	9 300		-	7 100	9 500	7 100
BAHRAIN		15 600	17 800	12 500	12 500	6 800 9 000	-	9 400	4 500 7 500
OMAN				11 900	11 900			-	
QATAR									-

TABLE 7 - A

HYPOTHETICAL TOTAL MONTHLY CHARGES (US$) DERIVED FROM TELEPHONE TARIFFS

VOICE GRADE CIRCUITS

Arab region / Intra-regional circuits

B: / A:	UN ARAB EMIRATES	SAUDI ARABIA	YEMEN A.R.	YEMEN (P.D.R. OF)	LIBYA	TUNISIA	ALGERIA	MOROCCO
EGYPT					4 900	9 900	17 700	17 700
LEBANON								
SYRIA	21 300	17 700	17 700	17 700				
JORDAN		12 600						
IRAQ	15 800	17 700		31 600				
KUWAIT	7 100-9 500	11 800	17 700	15 800				
BAHRAIN	5 600-9 000	6 300-10 200	17 600	12 500				
OMAN		8 500-11 800	17 800	11 900				
QATAR								

TABLE 7 - B

HYPOTHETICAL TOTAL MONTHLY CHARGES (US$) DERIVED FROM TELEPHONE TARIFFS

VOICE GRADE CIRCUITS

Arab region / Intra-regional circuits

B:	EGYPT	LEBANON	SYRIA	JORDAN	IRAQ	KUWAIT	BAHRAIN	OMAN	QATAR
A:									
UNITED ARAB EMIRATES		31 500	35 300	26 300	26 300	15 100	15 100	15 100	15 100
SAUDI ARABIA	14 900	17 700	17 700	12 700	17 700	11 800	8 400	13 900	10 600
YEMEN ARAB REP		17 700	17 700	17 700	17 700	17 700	17 700	17 700	17 700
YEMEN (P.D.R. OF)		20 200		12 800	19 200	9 600	7 700	9 600	9 600
LIBYA	4 900								
TUNISIA	9 900								
ALGERIA	17 700								
MOROCCO	17 700								

TABLE 7 - C

HYPOTHETICAL TOTAL MONTHLY CHARGES (US$) DERIVED FROM TELEPHONE TARIFFS

VOICE GRADE CIRCUITS

Arab region / Intra-regional circuits

B:	UN ARAB EMIRATES	SAUDI ARABIA	YEMEN A.R.	YEMEN (P.D.R. OF)	LIBYA	TUNISIA	ALGERIA	MOROCCO
A:								
UNITED ARAB EMIRATES	-	19 600 - 26 300		31 500				
SAUDI ARABIA	13 900	-	17 700	17 700	17 700	17 700	17 700	17 700
YEMEN ARAB REP	17 700	17 700 - 21 700	-					
YEMEN (P.D.R. OF)	9 600	11 500 - 14 000	3 800	-				
LIBYA					-	3 300	5 300	8 300
TUNISIA					3 300	-	2 800	3 900
ALGERIA						2 900 - 7 000	-	960 - 4 800
MOROCCO					4 800	3 900		-

TABLE 7 - D

HYPOTHETICAL TOTAL MONTHLY CHARGES (US$) DERIVED FROM TELEPHONE TARIFFS

VOICE GRADE CIRCUITS

Arab region / Intra-regional circuits

B:	AUSTRALIA	JAPAN	USA	VENEZUELA	UNITED KINGDOM	ITALY	IRAN	SINGAPORE
A:								
EGYPT								
LEBANON								
SYRIA		44 000					34 000	
JORDAN								
IRAQ								
KUWAIT		22 200					11 800	27 100
BAHRAIN		31 300					7 900-12 500	31 300
OMAN							11 900	
QATAR								

TABLE 8 - A

HYPOTHETICAL TOTAL MONTHLY CHARGES (US$) DERIVED FROM TELEPHONE TARIFFS

VOICE GRADE CIRCUITS

Arab region / Extra-regional circuits

B:	AUSTRALIA	JAPAN	USA	VENEZUELA	UNITED KINGDOM	ITALY	IRAN	SINGAPORE
A:								
UNITED ARAB EMIRATES							26 300	
SAUDI ARABIA				46 000			17 700	34 000
YEMEN ARAB REP		45 000					17 700	45 000
YEMEN (P.D.R. OF)		19 200					19 200	
LIBYA						6 000		
TUNISIA						3 700		
ALGERIA								
MOROCCO					4 200			

TABLE 8 - B

HYPOTHETICAL TOTAL MONTHLY CHARGES (US$) DERIVED FROM TELEPHONE TARIFFS

VOICE GRADE CIRCUITS

Arab region / Extra-regional circuits

	MALAYSIA	THAILAND	SINGAPORE	INDONESIA	BURMA	PHILIPP.	HONG KONG	KOREA	PAPUA	FIJI
MALAYSIA	-	R	T	S		T	T or S			
THAILAND	T	-	S	S	R	S	S	S		
SINGAPORE		S	-	S	R	T or S	T or S	S		
INDONESIA	S	S	S	-		S	S			
BURMA		R	R		-		R			
PHILIPPINES	T	S	T or S	S		-	T	S		
HONG KONG	T or S	S	T or S	S	R	T	-	S		
KOREA		S	S			S	S	-		
PAPUA NEWGUINEA 1)									-	
FIJI 2)										-

T = cable or radio-relay systems

R = radiotelephone circuit

S = satellite link

Notes

1) Only direct route to Australia (R or S)

2) Direct routes to Australia (T or S) and New Zealand (T)

TABLE 9 SOUTH EAST ASIAN REGION

DIRECT TELEPHONE ROUTES AND THE TYPES OF LINKS USED (1975-01-01)

(Source: ITU "List of International Telephone Routes 15th ed.)

	PERU	ECUADOR	COLOMBIA	BOLIVIA	VENEZUE	PARAGUAY	CHILE	ARGENT	URUGUAY	BRAZIL
PERU	-	S			S		S	S		S
ECUADOR	S	-	R				S	S		
COLOMBIA	S	R	-		R		S	S		S
BOLIVIA				-	R		R	R		R
VENEZUELA	S		T	R	-		S	S		S
PARAGUAY						-	R	R	R	R
CHILE	S	S	S	R	S	R	-	S or T	S + T	S
ARGENTINA	S	S	S	R	S	R	S	-	R	S
URUGUAY						R	T or S	R	-	R or T or S
BRAZIL	S		S	R	S/T	R	S	S	T or R or S	

T = cable or radio-relay systems

R = radiotelephone circuit

S = satellite link

TABLE 10 ANDEAN REGION

DIRECT TELEPHONE ROUTES AND THE TYPES OF LINKS USED (1975-01-01)

(Source: ITU "List of International Telephone Routes 15th ed.)

	EG	LE	SY	JO	IQ	KU	BA	OM	QA	AB	DU	SA	Y (AR)	Y (PDR)	LI	TU	AL	MO
EGYPT	-	T	T	R	R	T/S	T/S					T/S		R	T	T	T	T
LEBANON	T	-	T	R	T?	S	S		S/T			R						T
SYRIA	T	T	-	T	R/T	T						R			T			
JORDAN	R		T	-	R	R	R					R			R			S
IRAQ	S	T?	T/R	R	-	R	R					R		R				
KUWAIT	S/T	S		R	R/T	-	S					R						
BAHRAIN	S/T	S		R	R	S	-	R	T	T	T	T	R	R				
OMAN							R	-										
QATAR		T/S				T/S	T		-	T	T							
U.A.E.ABU DHABI		T/S				T/S	T	T/R	T	-								
U.A.E.DUBAI						T/S	T	T/R	T	T	-							
SAUDI ARABIA	R	R	R	R	R	R	T					-				R		
YEMEN (A.R.)							R						-					
YEMEN (D.P.R.)	R						R						R	-				
LIBYA	T		T												-	T	T	T
TUNISIA	T											R			T	-	T	T
ALGERIA	T														T	T	-	T
MOROCCO	T	T		S												T	T	-

TABLE 11 ARAB REGION

DIRECT TELEPHONE ROUTES AND THE TYPES OF LINKS USED (1975-01-01)

(Source: ITU "List of International Telephone Routes 15th ed.)

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ANNEX IV

REGIONAL INFORMATION RETRIEVAL CENTERS

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1 INTRODUCTION

The intention of this annex is to supply a background for an annual cost estimate for Information Retrieval Operations within a Regional Center.

Many aspects must be taken into account when the IR-system for the Regional Center is chosen. Some of the more important factors are

- system communication
- response time
- speed of terminals
- security

An Information Retrieval system must be easy to use. It must not take more than a couple of hours' training to be able to make a whole interrogation session, including logon and logoff.

A study (1) has shown that short response times are important for the user of the IR-system. The study suggest a maximum value of about 4 seconds. It is thus necessary for the center to use a computer of adequate processing power, to avoid queing and processing delays in the machine.

The IR-package should allow communication via high speed terminals. A Video Display Unit (VDU) with a speed of 120-240 characters/s is the most desirable solution. To provide hard-copy retrieval-output a local printer should be connected to the unit.

Many systems will not allow fast terminals. Slower asyncronous TTY-type connections is the only choice. These terminals have the advantage of providing hard-copy, but speeds might go as low as 10 characters/s. For IR purposes the minimum acceptable terminal speed is 20-30 characters/s. A lower figure would too much delay the considerable amount of output from the data-bases. Already at 20 characters/s a reference consisting of 1 000 characters would take 50 seconds to print.

One important aspect of an IR-system is security and access control. This might not be of such interest, however, in a center supplying only generally available databases. Therefore, an IR-package which has a limited security-facility could be chosen.

2 INFORMATION RETRIEVAL SYSTEM

2.1 AVAILABILITY

Table 1 gives a list of different IR-systems available. The list is condensed from (2).

Availability of IR-systems can be divided into two categories. The first category constitutes systems of a public ownership, and the second of private ownership. Most of the public systems are developed by universities or governmental organizations, and are available free of charge to non-profit organizations. For proprietory packages usually no such benefit exists.

The pricing policy varies a great deal. Some systems are available only on a purchasing basis, whereas other vendors will only supply a package under a lease-contract. The purchase price of an IR-system will be around $ 40 000. The lease-agreement will usually cost about $ 1 000/month.

2.2 STORAGE FACTOR

Important when estimating the amount of secondary storage needed is the Storage Factor (SF).

The Storage Factor may be defined as the ratio of the number of characters of storage required in the data base, to the number of characters contained in the original reference. Normally this factor is greater than one, indicating the extra space required by inverted files and indices. The value of the SF will vary depending on the IR-system used and type of data base considered. A data base covering a narrow subject area will have a low value, because of the limited vocabulary. Numerically the SF normally lies between 1.5 and 2.5.

TABLE I

INFORMATION RETRIEVAL SYSTEMS AVAILABLE

NAME	PUB-LIC	COMPUTER	TERMINAL ASYNC.	TERMINAL SYNC.	COST PURCHASE	COST LEASE
BASIS		UNIVAC 1108	x	x	$ 30 000	$ 1 500/month
CIRCOL		IBM 360/370	x		Not available	Not available
(Data/Central)		"	x		No	$ 1 800/month
DIALOG		"	x		-	-
GIPSY	x	"	x		$ 14 600	-
IMS (OEP)	x	UNIVAC 1108	x		Free	Not available
INQUIRE		IBM 360/370	x		$ 38 500	$ 1 325/month
INSYTE		BURROUGHS 5500	x		$ 27 000	$ 12 500 + $ 425/month
LEADERMART	x	CDC-6400	x	x	By arrangement	By arrangement
MASTER CONTROL	x	CDC-6600/7600	x	x	Available	-
MICROTEXT	x	IBM 360/370	x		"	-
MIRADS	x	UNIVAC-1108	x		Free ?	-
NASIS	x	IBM 360/370	x		For government	-
ORBIT III		"	x		$ 47 500	$ 2 000 + $ 950/month
PIRETS	x	DEC-10	x		Free	-
RECON	x	IBM 360/370	x		Free ?	-
RIQS	x	CDC 6400	x		Free	-
SHOEBOX	x	IBM 360/370		x	Free	-
SOLAR	x	"	x		Not known	-
SPIRES II		"	x		By arrangement	By arrangement
STAIRS		"	x	x	-	$ 700/month
TICON		"	x		$ 50 000	By arrangement
GOLEM		SIEMENS				

A value lower than one could be achieved if, for instance text compression methods were used for the primary file (the file containing the bulk text of the reference abstracts). An Information Storage and Retrieval project using text compression is presently under development in Sweden (3), (4).

3 COMPUTER INSTALLATION

3.1 HARDWARE

Generally the software of an IR-system is complex. The operations to be performed by the package mostly consist of

- large amounts of disk-accesses,
- merging and intersection of large arrays containing document pointers, and
- stepping through lists produced by the search, editing and displaying the query-result.

These operations indicate that an IR-system will be both CPU- and I/O-limited. To achieve efficiency for a large number of simultaneous users, a high performance CPU is a necessity. Short response time also requires that primary data is stored on direct access media, such as disks or drums. Disks being the cheaper alternative is consequently the most usual choice. To increase operational speed, large arrays must often be kept core-resident. This sets certain minimum boundaries on core storage. The computer must moreover be equipped with several channels and disk controllers to cater to the extensive disk I/O, generated by many simultaneous users accessing different data bases.

3.2 BUILDINGS

The cost of buildings, housing the Regional Center must not be forgotten. This cost may include other types of permanent installations such as floors, cooling equipment, electrical installations and so forth. No estimate is given here because of the great regional variation.

3.3 PERSONNEL

To run a Regional Center of this size certain qualified technical and administrative people are necessary. Only the computer oriented positions will be considered here.

The running of the computer will need at least one operator. He will work with the unit, mounting tapes and disks, distributing lists, starting special jobs etc. The transmission of SDI-results during night time, as stated in the contract, will make a multiple shift operation necessary. This in turn increases the number of operators.

The center will have to do limited software development. This requires a Systems Analyst who is well acquainted with the data bases, the IR-system and the computer. Typical jobs are:

- Conversion programs for external databases.
- Invoking corrections and updates of the operating- and IR-systems.
- Programs for the correction of erroneous data.

The Data Base Manager supervises the updates of the different data bases when they arrive at the center. He also holds the contacts with the data base suppliers, keeps a record of requests, controls data base security and the billing of the different customers.

In the smaller center the Systems Analyst and the Data Base Manager could be the same person. The limited amount of 100 000 references will not create too much administration or conversion problems. For the larger center, however, several systems analysts and data base managers may perhaps be needed. Each taking care of separate data bases and conversion routines.

4 ESTIMATE OF INFORMATION CENTER COST

4.1 MODEL DEFINITION

The cost estimate will be made for two Information Centers within the Regional Center. The two models will be based on the amounts of references and interrogation frequences outlined in the contract.

The smaller center RC(I) will have about 100 000 references accessible from the 15-25 terminals. Users of these terminals generate 300 requests/month.

The larger center RC(II) has an equal number of terminals, but 1 500 requests/month. This center is also supposed to store databases totalling 1 000 000 references.

4.2 SELECTION OF IR-SYSTEMS

Table 1 shows that the choice of an IBM-mainframe fits most systems available.

In the following calculation an IR-system called STAIRS/VS is selected. The selection is by no means a recommendation. It is only made in order to form a basis for a rough estimate of the yearly cost for an Information Center.

STAIRS is developed by IBM and is selected because it is a system with a great degree of "user-orientation". The people maintaining the databases will, however, have a more difficult job because of the complicated structure of the files.

4.3 CPU

The STAIRS system uses about 1.5% of the CPU-capacity per active terminal of an IBM 370/145 computer. This figure indicates that a dedicated computer could process a maximum of 50 simultaneously active terminals. This figure might seem too high for the suggested center but other activities such as file conversions and SDI-services, also must be performed on the computer. A core storage of 500 Kbytes should be sufficient.

A lower performance CPU, such as an IBM 370/135 could also be considered. The maximum number of simultaneous users in this case will be limited to about 25. It should be noted that in both cases indicated, a larger number of terminals can be connected as all terminals are not active at the same time. Based upon the average terminal traffic,

and the required availability, statistical considerations will show that the actual number of terminals supported by a center can be from two to four times higher.

In addition to the CPU, normal peripheral equipment such as console, cardreader, printer and magnetic-tape unit must be available.

4.4 DISK STORAGE REQUIREMENTS

The equipment described so far is more or less independent of the number or size of the data bases installed. This means that RC(I) and RC(II) both would have the same basic hardware costs. The direct-access storage cost on the other hand depends on the number of references. The amount of disk storage necessary can be calculated by forming the product of the following factors:

- The number of references each center should keep.
- The sizes of the references in number of characters.
- Storage Factor (SF).

STAIRS has a SF of about 1.6. The total number of bytes required by the two centers can equally be found in Table II, where hardware and software costs are summarized.

4.5 DATA BASES

One final important cost for an Information Center is the data bases. Many suppliers of these exist, as can be seen from Table 1.1 on page 8 of the main report. In Table 1.1 no cost information is given. Also, the charging grounds differ considerably. Some suppliers of data bases charge on a reference-retrieved or on a reference-printed basis. Others charge on a connect-hour basis.

One data base manufacturer in the scientific and engineering field charges $ 15/hour on a connect-hour basis. For the Regional Center between 300-1500 requests will be made/month. Each request results in a terminal session of about 30 minutes. A monthly data-base cost of $ 1500 - $ 7500 can thus be foreseen. This amount of money will give the users access to a data base of considerable coverage as many years back as the disk space will allow.

TABLE II

		Cost/month
CPU IBM 370/145	500 Kbytes	$ 30 000
Front-end computer		$ 4 000
Peripheral equipment		
Card punch		
Console		
Cardreader		
Printer		
2 Tape units		
Disk Packs		$ 14 000
STAIRS/VS + Communication package		$ 1 000
		$ 49 000
Disk units for 100 000 ref	160 Mbytes	
1 IBM 3330 Mod 11		$ 2 500
Total computer cost for RC(I)		$ 51 500
Disk units for another 900 000 ref		
7 X IBM 3330 Mod 11		$ 17 500
Total computer cost for RC(II)		$ 69 000

4.6 TOTAL COSTS

The estimated costs for the Information Retrieval (IR) Centers are dependent upon the software and the computer chosen. Personnel and housing expenses will not be included because of considerable regional variations. Table II presents monthly computer expenses for the two installations giving access to 100 000 and 1 000 000 references. Annual costs will be $ 618 000 and $ 828 000 respectively. It is interesting to note that an increase by a factor of ten in the number of stored references only will generate a cost increase of 34%.

5 ALTERNATIVE SOLUTIONS

5.1 ADD ON REGIONAL CENTER

Instead of creating a dedicated Regional Retrieval Center, an existing adequately large computer installation at one of the intended locations could be used. These considerations also pertain to a center renting computing-power from a Service Bureau. The IR would constitute an addition to previous computing center activities. This could necessiate an update of the original computer installation. At least disk storage could be needed, but also increase of CPU capacity and more communication equipment may be required. The cost effectiveness of this Information Center is of course impossible to estimate at this stage. With spare capacity on the CPU, the marginal cost would mainly be disk storage.

The manpower requirements for the center will also decrease as sufffienctly trained staff can be found at the original location.

5.2 MINICOMPUTERS

Mini-computers are becoming cheaper and cheaper. Their use would constitute a considerable saving in computer expenses. It has yet to be demonstrated, however, if they have the capability to efficiently handle the complicated information retrieval processes. Multiprocessor installation could be one solution. Another possibility would be a distribution of data bases and IR-systems in the network using minicomputers to control and access certain data bases only. The trans-

parency necessary for the user should in this case be supplied by the network. This last solution would allow a data base to be accessed by the most suitable IR-system making retrieval as efficient as possible. An "equalizer" between the different systems unifying logon, retrieval language etc, as discussed in Chapter 7 of the report will be required.

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ANNEX V

GLOSSARY

GLOSSARY

This glossary has been assembled in an attempt to further clarify some of the words and terms used in this report. Some words uniquely define or describe phenomena, conditions or entities. Considerable discussion may arise on the implication of other words. For this report, the interpretation used is identical with the one found in the glossary of D. W. Davies and D. L. A. Barbers book: "Communication Networks for Computers", John Wiley and Sons Ltd., London 1973, ISBN 0 471 19874 9.

The book is highly recommended to those who seek to penetrate the subject further or require a fuller explanation of a term than can be given here.

For a more general explanation of concepts and terms in information processing, interested readers are referred to:

> Guide to Concepts and Terms in Data Processing, Vol. 1 (I.H. Gould, Ed.). North-Holland, Amsterdam, 1971; 168 pp. ($ 7.00).
>
> IFIP/ICC Vocabulary of Information Processing. North-Holland, Amsterdam, 1966; Third Edition, Amsterdam, 1968, 220 pp ($ 7.00).
>
> IFIP Fachwörterbuch der Informationsverarbeitung. North-Holland, Amsterdam, 1968; 296 pp. ($ 12.60).

Adaptive Equalisation

Equalisation which is adjusted during the transmission of data so that it adapts to changing line characteristics. See also automatic equalisation.

Adaptive Routing

Routing in which the behaviour adapts to network changes such as changes of traffic pattern or failures. The information, or accumulated experience used for adaption comes from the data traffic being carried.

Aloha

A packet communication network in the Pacific. Center is University of Hawaii.

ARPA, ARPANET

Advances Research Projects Agency of the U. S. Department of Defence, which supports the ARPA resource-sharing computer network.

Automatic Equalisation

Equalisation of a transmission channel which is adjusted automatically while sending special signals. See also adaptive equalisation.

Baud

The unit of signalling speed. The speed in bauds is the number of signal elements per second. Since a signal element can represent more than one bit the term baud is not synonymous with bits per second.

CCITT

The International Consultative Committee for Telephones and Telegraphs, part of the International Telecommunications Union (UIT) which is an organ of the UN. CCITT is the forum for international agreement on recommendations for international communication systems, including data.

Channel

A path along which signals or data can be sent. Unless otherwise stated, the term implies one-way communication, whereas the term "circuit" generally implies two-way communication.

Circuit Switching

Switching as performed in the telephone network where a call is set up by establishing a circuit from one subscriber to another, the circuit being held for the duration of the call. Contrasts with message switching and packet switching (q.v.).

Concentrator

Usually means a line-concentrator in which a number of circuits (or lines) which are not all used at once are switched into a smaller group of circuits for economical transmission. A different concept is that of "message concentrator", which stores and forwards messages and also serves to concentrate the traffic from under-used circuits into fewer channels for transmission.

Cyclades

A packet switching network in France developed by IRIA.

Data

Numbers, facts, instructions, etc. which are represented in a formalized manner for processing, storage or transmission. By contrast, "information" is the significance attached to the data by people, but the distinction is not always recognized.

Duplex circuit

A circuit used for transmission in both directions at the same time. It may be called "full duplex" to distinguish it from "half duplex" (q.v.).

Dynamic Multiplexing

A form of time-division multiplexing in which the allocation of time to constituent channels is made according to the demands of these channels.

Four Wire Circuit

A telephone circuit is basically duplex (it carries voice signals both ways). In the local network this is achieved over two wires because the waveforms, travelling each way can be distinguished. In the trunk network, where amplifiers are needed at intervals and multiplexing is common, it is easier to separate the two directions of transmission and use (effectively) a pair of wires for each direction. At this point it is a four wire circuit.

Half Duplex Operation

The use of a bidirectional circuit only in one direction at a time.

Heuristic Routing

A routing method proposed by Baran in which delay data produced by normal data-carrying packets coming in on different links from a given source node are used to guide the outgoing packets as to be the best link for getting to that node.

HOST Computer

A computer which (in addition to providing a local service) acts as "host" to a communication computer (IMP) that gives it access to many other "hosts" via the network. Term used in the ARPA network.

IMP

Interface Message Processor or IMP is the name of a data switching centre of the ARPA network.

Interface

A boundary between two pieces of equipment across which all the signals which pass are carefully defined. The definition includes the connector signal levels, impedance, timing, sequence of operation and the meaning of signals. The term has been extended to include the idea of a software interface. The essence of an interface is its accurate definition.

Interface Computer

Part of a packet switching network which mediates between network subscriber and the high-level or trunk network. It can be regarded as containing a local area switch and terminal processors.

IRIA

Institute de Recherche d'Informatique et d'Automatique.

Leased Circuit

A telecommunication circuit leased by the user for his exclusive use between certain locations. No switching is employed, so the circuit is ready for immediate use. It may be point-to-point or multidrop.

Link

In one sense it is the physical communication path between two "nodes" or switching centres. In a different sense it means a conceptual link between two parties in a packet switching network, signifying that they are in communication with each other. The "parties" may be subscribers, or process within the subscribers computers.

Modem

The device which accepts a digital waveform and adapts it for transmission over an analogue channel, such as a telephone circuit provides, and also receives signals from the distant modem and converts them back to digital form. A contraction of "modulator-demodulator", but a modem contains more than this.

Multi-access

The ability for several users to communicate with the computer at the same time, each working independently on his own job.

Multiplexer

Equipment which takes a number of communication channels and combines the signals into one common channel of greater bandwidth or data rate, in such a way that the original signals can be extracted again by a demultiplexer. In a slightly different sense the term has been used for equipment which combines digital channels for access to a computer.

Multipoint Line, Multidrop Line

A four-wire circuit which is connected by branching points to several terminals distributed along its length. Known as a Multi-drop line in the U.S.A.

Node

In a topological description of a network a node is a point of junction of the links. The word has also come to mean a switching centre in the context of data networks, particularly in the context of packet switching.

On-line

Connected to a computer so that data can pass to or from the computer without human intervention.

Packet

A block of data handled by a network in a well-defined format including a heading. A maximum size of packet is set, and messages longer than that size have to be carried as several packets.

Packet Interleaving

Where packet interleaving is used on a line, each packet is completed before the next one is sent. This contrasts with the interleaving of bytes belonging to different packets, which is also sometimes used. Packet interleaving is appropriate at a computer's interface with the network.

Packet Switching Network

A network designed to carry data in the form of packets. The packet and its format is internal to that network. The external interfaces may handle data in different formats, for example byte by byte.

Protocol

A strict procedure required to initiate and maintain communication. Protocols may exist at many levels in one network such as link-by-link, end-to-end and subscriber-to-switch.

Real-time

A real-time computer interacts with external events and must respond fast enough to meet certain timing requirements of the overall system.

Routing Table

A table associated with a node which states for each packet destination the preferred outgoing link that the packet should use. Synonymous with "directory".

Store-and-forward

The handling of messages or packets in a network by accepting the messages or packets completely into storage then sending them forward to the next centre.

Terminal Processor

In a packet switching network it is convenient to treat terminals like other processors needing communication. To this end, each terminal has a process looking after it. This can be regarded as residing in a terminal processor (a separate processor is not essential - it could be part of an interface computer, for example).

Time-division Multiplexing (TDM)

A multiplexing method in which the time on the multiplexed channel is allocated at different times to different constituent channels. The allocation may be repeated regularly (fixed cycle) or may be made according to demand (dynamic).

Time-division Switching

Switching method for a TDM channel requiring the shifting of data from one slot to another in the TDM frame. The slot in question may carry a bit or byte (or, in principle, any other unit of data).

Time Sharing

The sharing of an equipment between several processes by giving the processes access to the equipment in turn, i.e. sharing out its time. Usually applied to processor time, but TDM is also a form of time sharing.

Traffic Matrix

A matrix of which the (i,j) element contains the amount of traffic originated at node i and destined for node j. The unit of measurement could be calls, or packets per second, for example, depending on the kind of network.

Virtual Terminal (or Terminal Image)

An ideal terminal which is defined as a standard for the purpose of uniform handling of a variety of actual terminals. The terminal processor is given the job of conversion between the virtual terminal and actual terminals.